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NATIONAL DAM INSPECTION PROGRAM. LAKE WAUKOMIS DAM (MO 10691) T--ETC(U)
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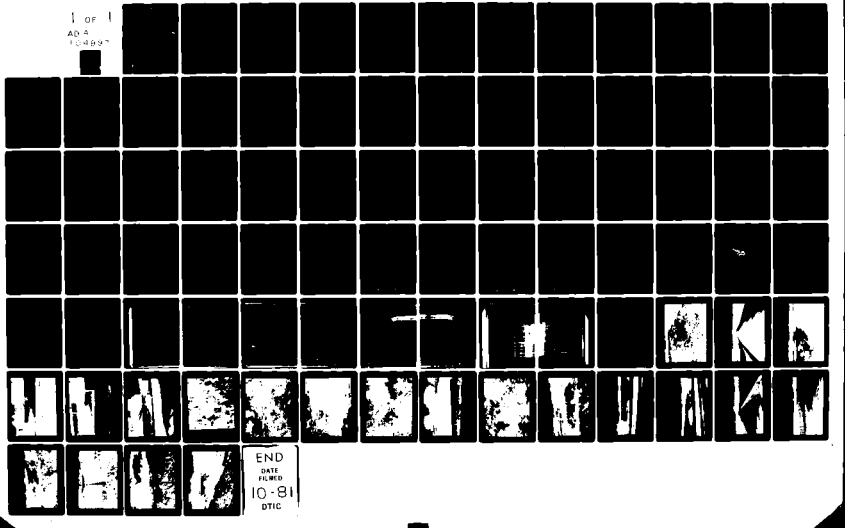

LEVEL II

PHASE I REPORT

NATIONAL DAM INSPECTION PROGRAM

LAKE WAUKOMIS DAM (MO 10691)
TRIBUTARY OF LINE CREEK
PLATTE COUNTY, MISSOURI

Phase I Rpt.

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DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS

AUGUST 1978

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A104897	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Lake Waukomis Dam (MO 10691) Platte County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Corps of Engineers, Kansas City District		8. CONTRACT OR GRANT NUMBER(s) N/A
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE August 1978
		13. NUMBER OF PAGES Approximately 75
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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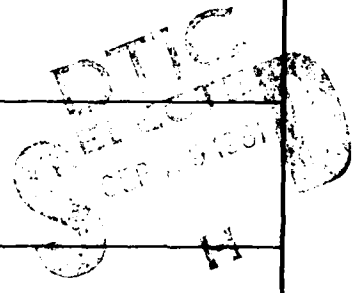

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Waukomis Dam (Mo. 10691) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Waukomis Dam (Mo. 10691). It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the following deficiencies:

1) A large slide area in the downstream embankment slope.

2) Seepage at the right abutment/embankment contact.

SUBMITTED BY: SIGNED
Chief, Engineering Division

24 OCT 1978
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

24 OCT 1978
Date

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
WAUKOMIS DAM - MO 10691
TRIBUTARY - LINE CREEK
PLATTE COUNTY, MISSOURI

SYNOPSIS

A. FINDINGS. Lake Waukomis Dam is considered to be unsafe and a threat to lives and property downstream of the dam. The 71 foot high dam is used for recreational purposes. It will be overtopped by a flood greater than 70% of the Probable Maximum Flood. An existing slide is of very serious concern since rapid displacement can result in catastrophic failure. Seepage in the right abutment is serious due to potential for major piping and abutment scour causing embankment failure. There are other minor problems of embankment erosion, left abutment seepage and a long-term, potentially serious, erosion problem in the spillway outlet channel. There is presently no system for dewatering the lake. The owner has engaged private consultants for investigation of dam problems. A civil defense emergency plan exists, but procedures for downstream warning apparently need improvement. The downstream hazard is rated high.

B. RECOMMENDATIONS. City employees and all other responsible persons should be instructed as to emergency procedures, especially in the absence/nonavailability of the civil defense personnel. Immediate action should be taken to improve the embankment stability, concurrent with proposed investigations. All actions should be done by such methods required to prevent a decrease in embankment stability. Investigations and corrective action should be taken to stop, or significantly reduce right abutment seepage. Provisions should be made for emergency dewatering of the lake and long-range plans should provide for stabilization of the spillway outlet channel erosion.

GLOSSARY OF ABBREVIATIONS AND TERMS USED IN REPORT
(also see Sketch Plan and Profile)

Abutment (Abut) - The valley walls, or an adjacent structure, against which the dam (embankment) is constructed.

Acre-Foot - The amount of water equal to 1 surface acre @ 1 foot deep, which is 43,560 cubic feet or 325,850 gallons.

Bedrock - All in-place rock, to include shale (Sh), sandstone (Ss) and limestone (Ls).

Benchmark (BM) - A permanent reference marker, usually in metal or concrete, used for survey elevation and/or location. If established for short term use is usually identified as a Temporary Benchmark (TBM).

Berm - A bench or flat area on an embankment slope. Usually slightly sloping, for drainage.

Cast-Iron Pipe - (CIP).

Conduit - A pipe or tube used to convey water. Normally part of the outlet works between the inlet and the outlet and usually thru or under the embankment.

Controlled - A valve or gate in an outlet works or spillway, used to control the flow (volume or depth) of water. The valve/gate and stem extensions are sometimes located in a "Control Tower."

Corrugated Metal Pipe - (CMP).

Crest - The top (highest plane) of an embankment or spillway floor, sill or weir.

Cubic Feet per Second (CFS) - A rate of flow. One CFS = 449 gallons per minute (gpm).

Dike - A short embankment used to control or divert the direction of water flow, ie.; a training dike. Sometimes referred to as a "berm" in the field notes.

Downstream (DS) - In the direction of flow, below the embankment or spillway crest.

Drop Inlet - Usually a vertical pipe or box, where water flows over the open top and free-falls to the conduit level.

Embankment (Emb) - The earth/rock fill dam (or diversion structure).

Freeboard - The height between the design maximum water level and the top of dam (TOD).

Grout - A fluid mixture, usually Portland cement and water, pumped into the cracks in rock to reduce, or stop, seepage.

Headwall - A vertical wall over (or around) the end of a conduit. Usually for erosion protection and stability. May be at either end, but usually downstream.

Horizontal (H) - Level (distance) used in slope description.

Inlet - The part of a structure or channel where water enters, such as an orifice, intake pipe or approach channel.

Invert - The bottom (flow line) of a conduit or other water passageway.

Kansas City District, Corps of Engineers - (KCD).

Kansas Department of Transportation - (KSDOT). State Highway Dept.

Kansas Division of Water Resources - (KSDWR).

Left (Lt) - As viewed looking downstream.

Length - Distance along the top of dam, between abutments. Also, the upstream-downstream distance for outlet works and spillways.

Normal Pool - The lake level most of the time. Usually the outlet works inlet or the spillway crest (if the OW inlet is closed).

Operation and Maintenance - (O&M).

Outlet - The part of a structure, conduit or channel where water is discharged, such as the downstream end of a conduit or downstream of a spillway crest.

Outlet Works (OW) - A water control structure, usually having three component parts; An inlet, conduit and outlet. The lake level is controlled by means of a raised inlet (riser pipe) or valve (or gate).

Piezometer (PZ) - A system for measuring a sub-surface water level.

Plunge Pool - A pool formed by water flowing out of a conduit and eroding the soil (or rock) below the end of the conduit.

Probable Maximum Flood (PMF) - The worst flood that could ever be predicted for a given area.

Reinforced Concrete Pipe - (RCP).

Right (Rt) - As viewed looking downstream.

Riprap - Rock, or other durable material, placed on slopes, banks and channel floors to prevent erosion. Also called stone protection or slope protection. May be graded or random size.

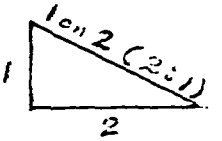
Seepage - A flow (any quantity) of water thru, under or around a dam.

Sill - A structure to maintain a level flow across a channel and to control headward erosion.

Sinkhole - A hole in the ground surface, caused by collapse of material into an underground hole.

Slope - The upstream and downstream faces of a dam. Also, a channel floor and sides, but normally not for vertical walls.

(Slope Angle) - Normally designated as the relationship of the rise to the run, ie.; a vertical distance to a horizontal distance. The USCE normally refers to the rise on the run (1V on 2H) whereas the SCS refers to the run to the rise (2:1 = H:V).



Soil Conservation Service - (SCS). (US Department of Agriculture).

Spillway (SW) - A structure normally designed to prevent overtopping of a dam. Reference types, by usage, are:

Service - Normally passes all outflow from the lake, usually where there is no outlet works or the inlet valve/gate is closed.

Limited Service - Normally passes flows (flood) in excess of the outlet works capacity.

Emergency - Normally a second spillway, at higher crest elevation than the service or limited service spillway, which will pass all flood waters in excess of the capacity of the other control structures.

NOTE: The SCS usually refers to the outlet works as a "principal spillway" and other outlets/channels as "emergency spillways."

Standard Project Flood (SPF) - The worst flood that could usually be expected in a given drainage basin.

Stilling Basin (SB) - A sub-structure at the downstream end of the outlet works or spillway, designed to dissipate the flow energy and reduce erosion.

Shoulder - Used to designate a change in slope, such as the top of dam (crest) and upstream slope contact, or the edge of a berm.

Toe - The bottom edge of an embankment (or slope), normally used in reference to the contact with the valley floor as opposed to contact with an abutment.

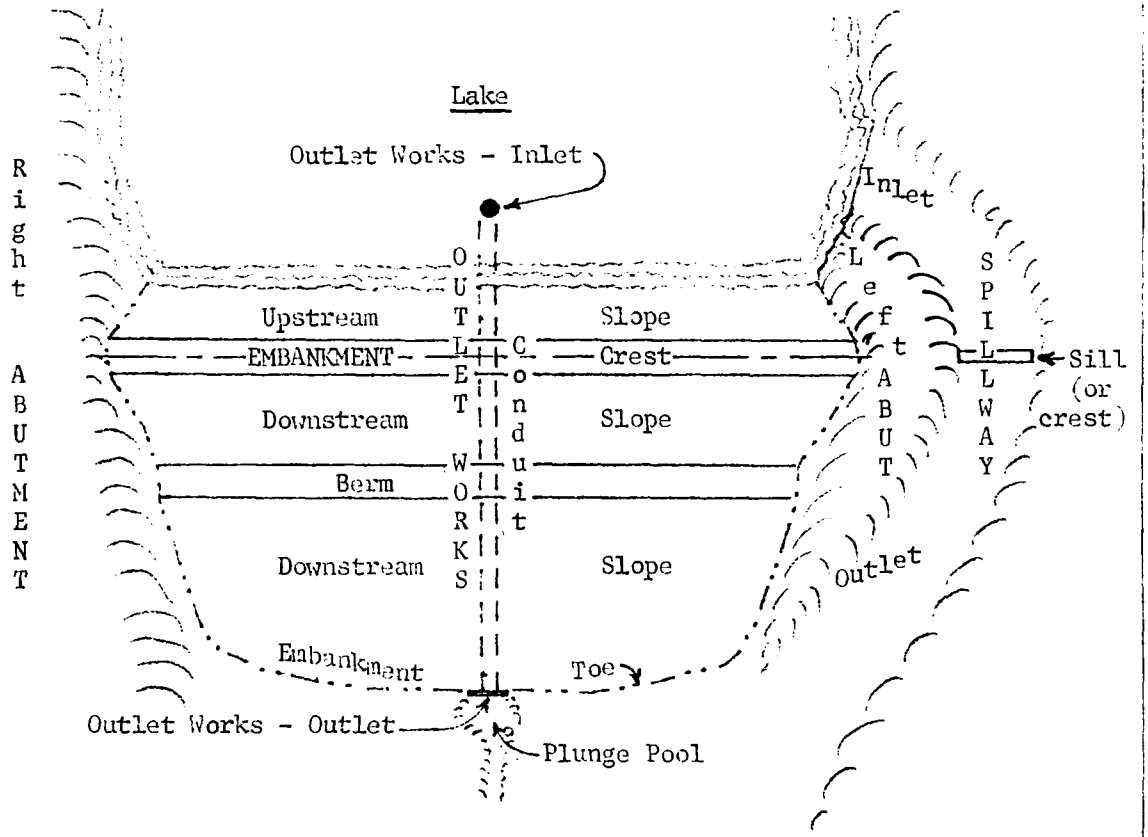
Uncontrolled - An outlet works or spillway with no valves or gates.

U.S. Army Corps of Engineers - (USCE).

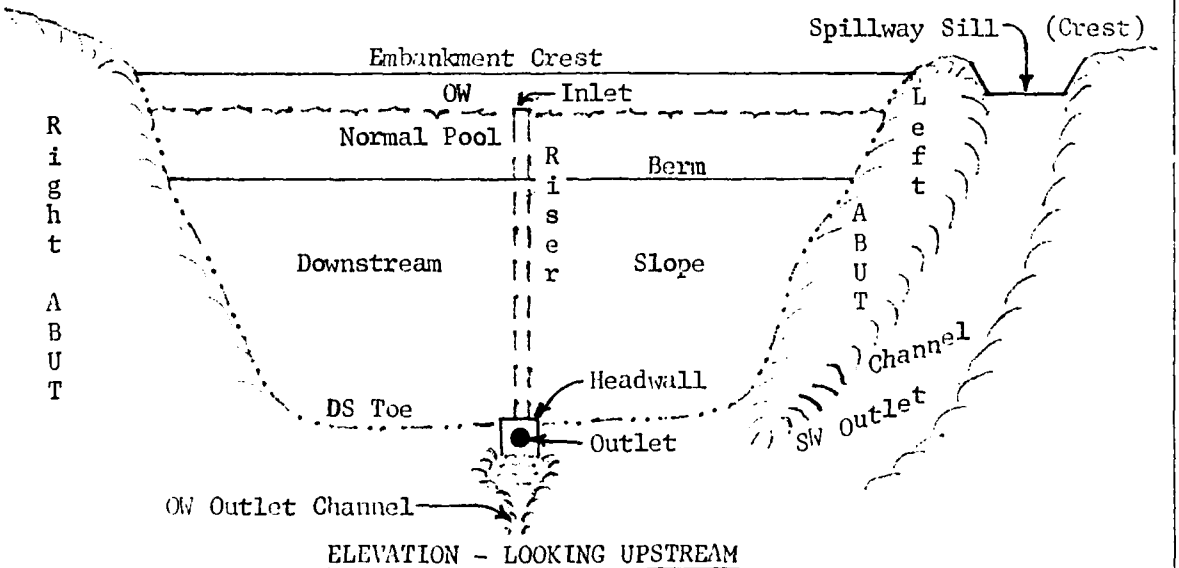
Vertical (V) - Height used in slope description.

Width - The upstream-downstream dimension of an embankment, or the dimension across a channel or rectangular conduit.

Weir - An elevated sill, or wall, usually with a curved section, as follows ---  .



TYPICAL PLAN VIEW



ELEVATION - LOOKING UPSTREAM

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM
WAUKOMIS DAM - MO 10691
TRIBUTARY - LINE CREEK
PLATTE COUNTY, MISSOURI

1. Authority. The dam was inspected under provisions of the National Dam Inspection Act, Public Law 92-367, 8 August 1972, in accordance with guidelines prepared by the Department of the Army, Office of the Chief of Engineers. The St. Louis District, USCE, is responsible for inspection of dams in Missouri; however, the Kansas City District agreed to inspect a limited number of these in the Kansas City Metropolitan area. Permission for entry was obtained from the owner's representative.

2. Inspection. The inspection was conducted on 28 June 1978 by members of the US Army Engineer District, Kansas City, accompanied, part time, by Mr. W. C. Fisher, Director, Lake Waukomis Association.

3. Description.

a. Owner: The Lake Waukomis (Homeowner's) Association, City of Lake Waukomis, Kansas City, Missouri.

b. Location: The dam is located in the SW¼ Section 17, Township 51 North, Range 33 West, Platte County, Missouri, in the southeast corner of the city of Lake Waukomis and bounding the city limits of Kansas City. The dam is on a tributary of, and about one mile upstream of the confluence with, Line Creek, a tributary of the Missouri River.

c. General: The 71 ft. high dam impounds a normal lake of 80.0 surface acres and 1,310 acre-feet storage, and is used for recreation. The lake level is controlled by a right abutment service spillway and there is no outlet works. Seepage from the left (East) abutment is collected in a left valley pond and pumped back into the lake during periods of low rainfall. The downstream end of the spillway slab serves as a section of an access road across the dam.

d. History: Available records were limited and the history presented hereinafter was developed from those records supplemented by verbal information. The dam was designed by Lake Development Enterprises, Inc., St. Louis, Missouri, as a recreational impoundment. Construction was started in 1945 by Russ Bell Contractor, Kansas City, Missouri. The completion date and any

other contractors involved is unknown. Subsequent to construction, a seepage problem apparently developed in the left abutment ridge which was studied (1963) and grouted (1964 & 1965) by the P.S. Judy Co., Kansas City, Missouri. The design grouting was reportedly not completed due to problems with access onto private property; however, flows were reportedly reduced about 80%. In 1966, a study and Plans and Specifications were made by Larkin & Associates, Kansas City, Missouri, relative to spillway widening and an embankment raise which incorporated a two-lane roadway across the dam. Construction of this work was performed by the Damon Pursell Construction Co., Kansas City, Missouri, during late 1966 or 1967. A study to evaluate dam safety, replacement cost and monitoring and inspection programs was made by Woodward-Clyde Consultants, Kansas City, Missouri in 1976. This study reported displacement (slide?) conditions in the left embankment and seepage and hydrologic conditions and recommended further studies. Siltation studies and proposals were made by Larkin, during 1977, and dredging of the lake was in progress during the inspection. A series of four lines of settlement/displacement pins were established on the embankment in 1977 by Anderson Survey Co., Kansas City, Missouri and resurveyed in 1978 with both horizontal and vertical displacements noted. The owner has a continuing program with private consultants for study and analyses of deficiencies.

d. Embankment. The earthfill embankment has a crest length of about 785 feet and a height above the downstream channel of about 71 feet. Crest width is about 20 feet. The downstream slope is about 1V on 2H except for the top 5± feet which are about 1V on 1H. The upstream slope is about 1V on 3H except for the top 5 to 7 feet, which ranges between 1V on 1H and 1V on 2H. No embankment design or construction data are available; therefore, interior zoning and foundation treatment are unknown. The 1966 modification raised the (design) crest elevation to 945.8 feet m.s.l. (based on a USGS map elev. of 939 ft. for normal pool). Two pipes extend thru the embankment, from 3 to 4 feet below top-of-dam. The lowest is a 6" steel pipe about 300 feet from the left (east) abutment and is used for return of water from a seepage collection pond in the left, downstream, valley. The other pipe is 8" pvc, about 500 feet from the left abutment, which is a discharge line used to convey dredged material to a pond in the valley center at the downstream toe of the embankment.

e. Outlet works. There is no outlet works.

f. Spillway. The existing service spillway is an uncontrolled, concrete lined, curved chute about 300 feet long and tapering from 61 feet wide at the upstream (crest) and to 35 feet wide at the downstream end. Crest elevation is 939.0 ft. m.s.l. (USGS) and

the downstream end elevation is 933.8. Spillway discharge is into a tributary of the impounded stream, separated by a narrow ridge, and plunging over limestone and shale to the stream bed about 48 feet below.

4. Available Engineering Data. Engineering data obtained before, during, and after the inspection consists of:

a. "Investigation of Leakage - Lake Waukomis Dam", Philip S. Judy, Co., Kansas City, Mo., undated report (believed to be late 1963 or early 1964). The Judy Company reportedly has extensive (inactive) files on Lake Waukomis and may have a set of original plans.

b. "Dam and Spillway Improvements - Lake Waukomis - Platte County, Missouri", Larkin & Associates, Kansas City, Mo., reports and contract documents dated Feb - Jul 66.

c. "Earth Dam and Spillway Facilities - Lake Waukomis - Kansas City, Mo.", Woodward-Clyde Consultants, Kansas City, Mo., report dated Nov 76.

d. "Plat of Survey" (embankment alinement), Anderson Survey Co., Kansas City, Mo., prepared June 1977 and revised (re-survey) June 1978.

e. "Siltation Study", Larkin & Associates, report transmitted June 1978.

5. Inspection Findings.

a. Operation and Maintenance Program. There are no outlet works or spillway gates requiring operation. Water return from the downstream seepage collection pond is currently done only on rare occasions. This pond was being pumped during inspection to replace water loss from dredging. No regular technical inspections are made; however, there is an understanding that any changes or unusual occurrences noted by anyone will be reported to the board of directors. During heavy rainfall, the City Chief of Maintenance (or other designated person) maintains a watch on spillway flows and on the embankment and photographs are taken of the high flows. The city has a Civil Defense Director and coordination with higher level CD agencies. Emergency procedures are not clearly understood by other city employees or residents. Scheduled maintenance consists of spraying (brush and weeds) the embankment in the spring and hand cutting in the fall (too steep to mow). Other maintenance is performed as required.

b. Embankment. Field observations indicate that the embankment is constructed primarily of valley and terrace alluvial materials consisting of lean clays and occasional gravelly clays which are from reworked, upland, glacial till. The foundation is shale and limestone, probably with a thin veneer of alluvium in the valley and a cutoff trench, to bedrock, under the crest section. The lake level was at the spillway crest. The upstream slope was riprapped and in good condition with only minor erosion and stone displacement. The downstream slope had tall grass, moderately sparse brush, small tree growth, and had been recently sprayed. There was moderate brush and medium sized tree growth on the downstream toe. A siltation (settling) pond extends across most of the valley, adjacent to the toe. There was moderate erosion, seepage and brush growth at the left (east) embankment/abutment contact. On the right embankment/abutment contact there was minor erosion, heavy brush (and some tree) growth and significant, locallized, seepage about 30 feet below the dam crest. The crest roadway had evidence of both horizontal and vertical displacement, in an approximate 150 ft. wide arcuate zone of cracks with the apex at the upstream guardrail about 400 ft. from the left abutment. Both upstream and downstream guardrails had pronounced vertical drop and downstream horizontal displacement, in the arcuate zone. The remainder of the guardrails had a slight inclination away from the roadway. Level readings, by the inspection team, indicate the displacement zone to be lower than the remainder of the crest; however, the crest is from 0.29 ft. to 1.45 ft. above design grade. Levels run on four lines of pins, by the Anderson Co., indicate maximum vertical movement of 0.07 ft. and maximum horizontal movement of 0.10 ft. from June 1977 to April 1978. The displacements are indicative of an active slide, and the absence of cracks or bulges on the downstream slope indicate a deep-seated slide. There was no evidence or report of embankment overtopping.

c. Outlet Works. None

d. Spillway. The spillway appears to be in relatively good condition. There was minor erosion at both sides of the downstream end, where lateral (road) ditches entered the spillway channel. The left ditch showed recent repair with earth/rock fill. Downstream of the spillway slab the Spring Hill and Merriam limestone members are being ravelled by scour action, in open joints, and by block slumping/plucking. The plunge (pool) is stepped about the middle of the Bonner Springs shale and bottoms on a 2.3 ft. thick limestone bed, about 48 feet below the spillway slab (lip).

e. Other. Silt was being dredged from the southwestern arm of the lake and deposited in the ponding area at the downstream toe. The Lake Association has a current contract with Woodward-Clyde Consultants for monitoring and evaluating dam conditions.

6. Hydrology. The upstream drainage area is 1.9 square miles. Available reservoir storage is 660 acre-feet between the spillway crest and top of dam, with a normal lake area of 80 acres. A maximum pool stage of 947.3 ft., m.s.l. would result from the Probable Maximum Flood (PMF). The lowest top of dam section would be overtopped a maximum of 1.3 feet, with a total duration of overtopping of about three hours. Lake Waukomis would be capable of passing approximately 70% of the PMF without overtopping.

7. Stability. In order to determine the safety factor of the embankment slope against sliding, a comprehensive sampling and testing program (or an analysis of design and detailed construction records and tests) would be required. That is beyond the scope of this Phase I report. The average strengths necessary for various safety factors can be determined by a simplified analysis. The guideline criteria require a minimum safety factor of 1.50 for the downstream slope under normal pool conditions. Assuming an average shear strength for the embankment and foundation, the following safety factors were determined:

Average Strength	Safety Factor
tan $\emptyset$ = 0.60, cohesion = 0 tsf	0.86
tan $\emptyset$ = 0.70, cohesion = 0 tsf	1.00

It is estimated that the actual strength would be less than tan $\emptyset$ = 0.70 and cohesion = 0 tsf. From this it is estimated that the safety factor of the embankment is less than 1.00, which is substantiated by the active slide area observed.

8. Seepage. Minor seepage was noted along the left abutment/embankment, with moderate seepage issuing from the right abutment ridge about 100 to 200 yards downstream of the dam. Minor thru seepage is apparent, from vegetation type at the toe of the slide area and downstream of the toe in the valley section. Serious seepage was noted at the right abutment/embankment contact, about 30 feet below the embankment crest. The seepage is at the level of the Merriam limestone and flow was estimated at about 400 gpm. The estimated flow during 1976 inspection (Woodward-Clyde) was 150+ gpm. No turbidity was observed, however, vegetation, debris and large stones (dumped) obscured the flow. A minor amount of seepage from under the downstream end of the spillway slab was also noted.

9. Downstream Hazard. A high hazard opinion was unanimous. In the event of a sudden dam failure at least 16 residences were considered to be endangered in the first ½ mile downstream, with more along Line Creek.

10. Conclusions.

a. The hazard rating is high and the dam is considered to be unsafe.

b. There is serious concern over the stability of the embankment in the displaced zone. Visual evidence and engineering data indicate a deep-seated active slide, extending from the upstream crest, thru the embankment and foundation, to the downstream toe. Embankment failure, with catastrophic results, could occur at any time and especially after heavy rainfall and/or a rise in the lake level.

c. The right abutment seepage is considered serious due to potential for rapid erosion and subsequent failure of the embankment. Left abutment seepage is considered to be less serious but has the potential for increasing.

d. The capability to pass 70% of the PMF does not meet the guidelines criteria of passing 100% of the PMF. Furthermore, due to the presence of the active slide any overtopping would probably result in a very sudden failure. Any pool stage that approaches the top of dam could precipitate a dam failure due to increased saturation of the active slide or increased forces on the dam.

e. None of the erosion is serious but will require continuing maintenance. Erosion of the spillway plunge-pool face is a slow, but progressive, action which will eventually result in loss of the access road and lower end of the spillway slab, unless halted.

f. There is no permanently installed means of draining the lake, in the event of emergency or for repair work.

11. Recommendations.

a. Familiarize all city employees and owner's governing board in emergency (warning) procedures.

b. In addition to current instrumentation and engineering studies, the owner should initiate construction of a downstream toe berm using an interior drainage system or pervious material (rock), or lower the lake level.

c. Use dry methods only, when drilling and/or installation of instrumentation devices. It is possible that introduction of liquids into the slide area could cause additional movement.

d. Initiate studies of the right abutment seepage, to include accurate flow measurements. Any program for future grouting should include lowering the lake level to below the Merriam limestone ledge (prior to and during grouting).

e. Monitor left abutment seepage for both flow rate and turbidity.

f. Consider rock-bolting and slush-grouting of the Plattsburg Formation at the downstream end of the spillway and possibly construction of a protective facing from the spillway to the plunge pool.

g. Provide permanent drawdown facilities. One means would be by modification of the existing left abutment, seepage-water, return system.

PAUL D. BARBER
Chief, Engineering Division

has seen it.

ED

EXECUTIVE OFFICE
STATE OF MISSOURI
JEFFERSON CITY

JOSEPH P. TEASDALE
GOVERNOR

September 13, 1978

Colonel John S. Wilkes, III
Acting District Engineer
Corps of Engineers, St. Louis District
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Wilkes:

This is in response to your letter of August 24, in which you identify Lake Waukomis Dam in Platte County, Missouri as unsafe (albeit in a non-emergency category), and supply this office with a copy of the Corps' Draft Inspection Report (PhaseI). We want to thank you for making this report available to us for comment and opportunity for action.

Geologists of our Division of Geology and Land Survey (DNR) have reviewed this report. They concur with the unsafe designation and point to data extending back to 1963 that suggests even more concern than is implied in your report. Records of visits by State Geological Survey staff since 1963 tend to emphasize the need for immediate attention. Their technical comment is provided in the attached memorandum.

As a result of your report, I am greatly concerned about the safety of persons downstream of Lake Waukomis and of course, about the value of the lake to the lake residents. I understand that according to your present report. Perhaps in this instance, my greatest service would be to attempt to emphasize my concern directly to the owners association, urging them to adopt the recommendations that your final report includes. I will also ask W. B. Howe, State Geologist and Director our Division of Geology and Land Survey to make immediate contact with the Lake Waukomis (Homeowners) Association, City of Lake Waukomis, and with Kansas City authorities. I anticipate such liaison will assist the Homeowners Association and City authorities of Kansas City in implementing repair procedures.

The report on Lake Waukomis is an excellent example of the benefits of the National Dam Inventory and Inspection Program. As I have noted, state personnel were aware of problems at Lake Waukomis. However, the Inspection Report furnished by your office served to focus much needed attention on those problems by engineering documentation. It is that type of report that is required to

document the need for immediate attention and repair on dams that are unsafe and pose a threat to persons downstream.

For your records, I am attaching a copy of my letter to the Lake Waukomis Homeowners Association.

Very truly yours,

Joseph P. Teasdale

GOVERNOR

JPT:cam

Enclosure

MEMORANDUM

TO: Wallace B. Howe

FROM: James H. Williams

SUBJECT: Comments by J.H. Williams on Waukomis Dam, Corps of Engineers Report Dated 24 August 1978

DATE: September 5, 1978

1) Additional background data in DG&LS files should have been reviewed because of significance relative to changes in leakage conditions.

2) I believe hazard may be even greater than Corps report implies because of background data as follows:

1963, Oct. 29 - J.A. Martin reports leakage left abutment, no mention of right abutment. I infer from that no leakage.

1963, Nov. 22 - Bill Whitfield, Judy Company, grouted left abutment. He reports that no leakage or slides in right abutment.

1968, Dec. 12 - J.H. Williams reports leakage left abutment, none in right abutment. Spillway repaired as of Dec. 1968 but Bonner Springs shale being eroded back under Plattsburg.

The significance is this. The condition as now appears to exist represents a major change occurring some 30 years after construction. This major change involving significant leakage, likely through the Spring Hill, and perhaps Merriam is affecting a shale beneath, the Bonner Springs. If this is occurring at the dam-abutment contact, there are serious implications. The old left abutment leakage did not occur at the dam-abutment contact. Therefore, I believe, from reports only, not having seen the site recently, that there is a need or urgency not implied in the Corps report.

I disagree with the Corps of Engineers recommendations to this point:

a) Grouting should not be even suggested at this stage due to possible creation of pore water pressures that could cause problems at the dam-shale abutment contact.

b) It is of little value to dramatize civil defense given no means to assure continued training of persons involved, it will fail when critically needed.

I recommend in this order and note as immediate priority recommendations:

a) Immediately begin or continue, as the case may be, stability study of dam by persons experienced in the design and construction of earthen dams.

b) The right abutment seepage is considered serious due to potential for rapid strength loss in the shale and piping of the fill. Investigation must focus on that. Left abutment seepage is considered to be less serious but has the potential for increasing.

c) The slide as noted in the Corps report is considered serious. Investigation must also immediately focus on that.

d) The other Corps recommendations are appropriate but of less priority. However, in a situation as this, I question that any specific recommendations, such as grouting or berming even be mentioned. Obviously, the lake owners will be hard pressed being the owners of an expensive dangerous structure. Even though their sincerity is not in question, witness the fact they have employed consultants which is an exception to the rule in Missouri, they are faced with the need to react. Given the circumstances, one reaction could be to follow the specific recommendations in the report to the point of retaining a consultant in the form of a grouting firm to grout. This is not what is needed, and could do more harm than good. The consultant does what he is hired to do. He is not a dam expert, doesn't pretend to be, hopefully, and the lake owners have reacted to the report.

FIELD INSPECTION REPORT

NOTE:

Entries on the following Field Inspection Report may differ from findings, conclusions and recommendations stated in the foregoing Phase I Report.

The Field Inspection Report is a worksheet used to provide guidance during the field inspection. The report contains questions and opinions, in addition to observations, information, surveys and other field data. The field inspection report and all other available data are subject to further investigation, analyses and review in preparation of the Phase I Report.

ID ~~XS~~ MO 10691

Name of Dam Waukomis

Name of Quad Parkville (Mo.)

Date 6/23/73

NATIONAL DAM INSPECTION PROGRAM
REPORT OF FIELD INSPECTION

GENERAL

1. Name of owner: Lake Waukomis Association
969 South Shore Drive, City of Lake Waukomis
Mailing Address: Kansas City, Mo. 64151

2. Location
County Platte

Section SE 17 Range 33 W Township 51 N

3. Is location shown correctly on county map?

(X) Yes (correctly)
( ) Yes (incorrectly)
( ) No

4. Is dam on inventory?

(X) Yes (corrections attached)
( ) No (completed form attached)

5. Type of dam (check all appropriate)

(X) Earth and/or rockfill (use MRK A)
( ) Concrete and/or masonary (gravity) (use MRK B)
( ) Other
Explain

6. Type of spillway (secondary spillway)

Controlled	Uncontrolled	Type	Use Form
( )	( )	Pipe or Conduit	MRK C
( )	(X)	Chute or notch	MRK D
( )	( )	Overfall	blank sheet
( )	( )	Other	

Explain Concrete lined chute with no weir (sill) or stilling basin

7. Type of outlet works (primary spillway)

( ) Controlled
( ) Uncontrolled
(X) Other none

8. Do the following exist?

	Yes Inclosed	Yes, Not Inclosed	No	Don't Know
Design data	( )	( )	( )	(X)
(partial) Plans and specs	( )	(X)	( )	( )
Shop drawings	( )	( )	( )	(X)
As builts	( )	( )	( )	(X)
O & M Manuals	( )	( )	( )	(X)
Inspection Reports	(X)	( )	( )	( )

Remarks (Include Owners AE or source of info) Owners aware of the problems, (Studies by Woodward/Clyde, Larkin and Judy) et al, Specs for original construction and P&S for emb. raise & SW modification.

9. Is there any flood warning system at the dam?

( ) Yes (X) No
Remarks _____

10. Is there any evidence that the dam has ever been overtopped?

(X) No

( ) Yes
- ( ) High water marks
- ( ) Erosion
- ( ) Evidence of repair
- ( ) Verbal reports
- ( ) Other

Explain. _____

11. Estimate the degree of lake siltation.

- ( ) No noticeable siltation in lake
- ( ) Some minor amount of siltation
- (X) Lake has major amounts of siltation

Remarks Dredging NW portions out now.

12.

Downstream Improvements	Valley Distance (miles)	Type of Improvement (indicate number)										Loss Of Life Potential			Economic Loss Potential			Remarks
		Occupied dwelling	Unoccupied dwelling	Agricultural Building	Industrial Building	Other Building	Road	Railroad	Urban Area	Dam (give ID number)	Other	Likely more than 4	Likely 4 or less	Possible, but not likely	Less than $50,000	$50,000 to $500,000	More than $500,000	
1	0.2			X							X			X	X			horse barn & main power line
2	1/4	1					X						X		X			Lake Waukomis Road
3	0.3	X					X					X					X	15 houses (occupied) in valley.
4	0.5	X					X					X					X	Roads and utilities
5																		
6																		
7																		
8																		
9																		
10																		

ID KS MO 10691

The above list was ended because:

( ) We do not feel that points further downstream are seriously threatened by the dam
(X) We have already established a very high downstream hazard, but further downstream hazard exists
( ) We cannot tell, further study is needed
( ) Other
Explain _____

13. Are there any type of instruments on the dam?

(X) No ( ) Yes
( ) Monumentation
( ) Piezometers
( ) Weirs or other water measuring device
( ) Other
Explain _____

14. Give your overall opinion of the downstream hazard potential.

Team member	1. High	2. Significant	3. Low	Can't Decide
R. Johnson	(X)	( )	( )	( )
R. Browning	(X)	( )	( )	( )
R. Schwartz	(X)	( )	( )	( )
W. Strobach	(X)	( )	( )	( )

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (No permanent structures for human habitation)	Minimal (rural or agricultural areas where failure may damage farm buildings, limited agricultural lands or townships and country roads)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Predominantly rural or agricultural areas where failure may damage isolated homes, secondary highways or minor railroads)

High	More than few	Excessive (Serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways or railroads)

15. Information on upstream drainage area.
Check one that best describes relief:

( ) flat lands
( ) low hills
( ) steep hills
(X) other
Explain Rolling upland

Give approximately percentage of each:

Urban 20 %
Timber 50 %
Grass land 30 %
Crop land ____ %

Explain _____

Total 100%

Remarks (give any information that would help evaluate the runoff characteristics of upstream drainage area) (Dams, US, etc.) _____

Heavy timber and brush US of developed (housing) area.

16. Check which item best describes the condition of the channel upstream of the lake.

( ) Clear of debris, trees, etc.
( ) Some minor debris in channel and a few trees periodically in channel
(X) Much brush in channel and many trees adjacent to channel

Remarks _____

17. On a separate sheet, sketch the overall plan of dam and spillway and outlet works. Describe features not adequately shown on sketch or photos. Include photos as necessary to show features.

See inclosed sketch plans, profiles and photos

What recommendation do you have for improving the safety of the dam? (Discuss Feasibility of improvements.)

1. Add pervious material as a downstream berm across valley section.

2. Grout right abutment - check left abutment too for possible grouting.

3. Rock bolt upper limestones. Check on paving the outlet.

Shape and butter with concrete.

Participants in the dam inspection:

Name	Title	Agency
R. Johnson	Engr Geologist	USCE
R. Browning	Soils Engr	USCE
R. Schwartz	Hydro Engr	USCE
W. Strobach	Struct. Engr	USCE

List of attached forms:

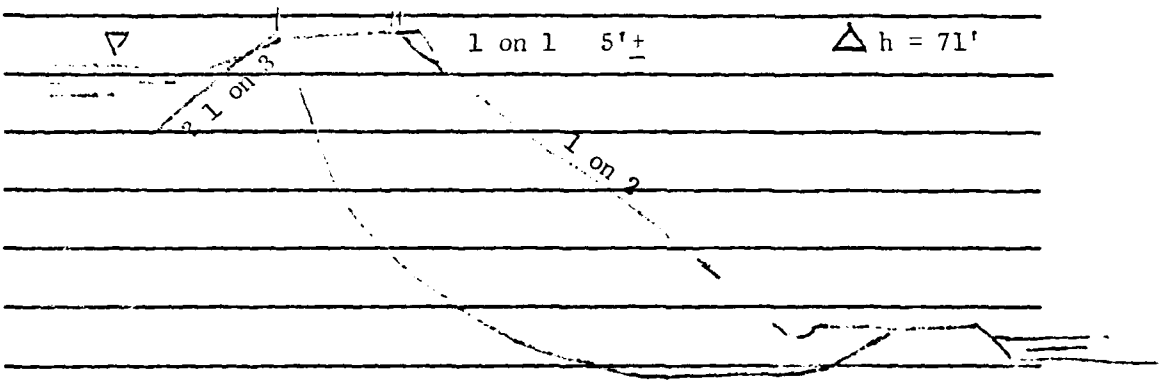
( ) Eng Form 4474
( ) Eng Form 4474A
(X) County map & other (specify) Extracts of USGS quad sheets
(X) MRK Form A - Embankment Dam
( ) MRK Form B - Concrete or Masonry Dam
( ) MRK Form C - Pipe or Conduit
(X) MRK Form D - Spillway
(X) MRK Form E - Surface condition of concrete
(X) MRK Form G - Site Geology
(X) 22 Photographs
( ) Other. (list)

Date 6/28/73

ID ~~KS~~ MO 10691

Embankment Dam

1. On a separate sheet, draw one or more sections through the dam. Show crest width, height, slopes, location of outlets, slope protection, water surface, high water marks, eroded or damaged areas, seepage, etc. Use datum established in question. Describe features not adequately shown on sketch. (Attach photos) (How constructed, history of project, etc.)



2. Are there any signs of instability?

(X) Cracks
( ) Creep
( ) Sloughing
(X) Irregularities in crest or waterline
(X) Excessively steep slopes
(X) History of sliding
( ) Other

Explain Dam was raised (a reported) 10 ft. (12 yrs. ago) probably 1966 surcharged a borderline steady seepage condition.

Give your opinion of the stability of the dam.

( ) Embankment has no visible stability problems and may meet criteria set forth in the guidelines
( ) Embankment has no visible stability problems but probably does not meet the criteria set forth in the guidelines
( ) Embankment has minor stability problems but unlikely to lead to failure
( ) Embankment has stability problems which if not corrected could lead to failure
(X) Embankment has serious stability problems which could lead to failure at any time

MRK A

( ) Other
Explain There is a slide in the valley reach (incipient - barely visible), but probably deep-seated.

3. Is there any evidence of seepage?

Yes	No	N/A	Can't Tell	
(X)	( )	( )	( )	Downstream slope
(X)	( )	( )	( )	Downstream of dam
(X)	( )	( )	( )	Left abutment (looking downstream)
(X)	( )	( )	( )	Right abutment (looking downstream)
(X)	( )	( )	( )	Around structure
( )	( )	( )	( )	Other

Explain fully (quantity, turbidity, location, point source or general area, etc.) There is serious abutment seepage (est. 400 gpm) on rt. intercept. Some left abutment seepage - less serious, some minor underseepage and very minor thru seepage in valley section. Appears to have minor seepage from under SW slab, DS end

Give your opinion of seriousness of seepage.

( ) Unlikely that it will become a problem in the forseeable future
( ) May or may not become a problem
(X) Is a problem but not likely to lead to failure (left abutment)
(X) Is presently a problem which if not corrected could lead to failure (right abutment)
( ) Serious problem which could lead to failure at any time

Remarks: The abutment seepages are serious, (especially right abutment). Recommend monitoring and possibly grouting.

4. Is there any evidence of erosion?

Yes	No	N/A	Can't Tell	
( )	(X)	( )	( )	Upstream slope
(X)	( )	( )	( )	Downstream slope
( )	(X)	( )	( )	Crest
( )	( )	( )	( )	Around structures
(X)	( )	( )	( )	Right abutment (looking downstream
(X)	( )	( )	( )	Left abutment (looking downstream)
(X)	( )	( )	( )	Others

Remarks Spillway outfall plunge pool - minor erosion at intercepts of embankment/abutment.

Give your opinion of the seriousness of the erosion.

(X) Unlikely that it will become a problem in the forseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure
( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at any time

Describe material being eroded - estimate uniform soil classification.

Spillway - shale and limestone. Embankment - lean clay (CL-A/B)

Is there any evidence of dispersive clays? ( ) Yes (X) No

Explain

Is there any slope protection on the embankment? (X) Yes ( ) No

Describe (type and condition) Limestone - appears to be"quarry run" or "as excavated", moderately deteriorated (freeze-thaw) but well interlocked. No problem areas noted.

5. General condition of dam - maintenance, mowing, trees in embankment, animal burrows, etc.

Needs mowing and tree spraying; otherwise, well maintained.

6. Based on the exposed material in the downstream channel and other physical evidence, describe the foundation material.

Lean clay soils overlying shales and limestones.

7. In your opinion, is there anything about the embankment which warrants special consideration in deciding whether or not to perform a more detailed investigation? (X) Yes ( ) No

If yes, why? Also, what specific problem or questions should the analysis try to resolve?

The embankment stability should be studied further. Right abutment end-around seepage is serious. The embankment is in a state of full embankment failure. It needs only a surcharge pool and wet seasonal conditions to generate a rapid , massive slide resulting in a full breach of the dam. This might not occur for several years, but it could occur next week. The seepage conditions are very serious and are additive to the shear problems. A piping (solution) failure is also a possibility.

Date 6/23/78

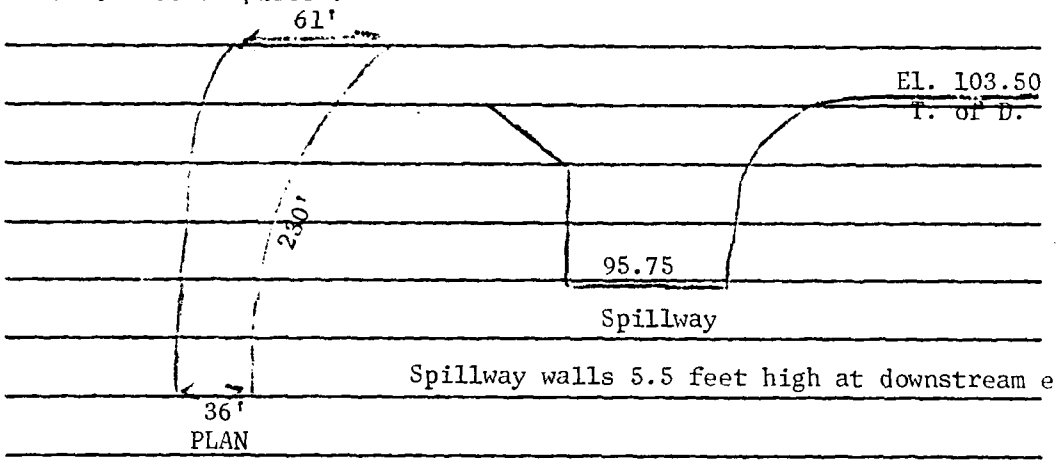
ID KS MO 10691

Spillway Data

1. Give name of feature inspected (as shown on drawings, common usage, etc.)

( ) Emergency spillway
( ) Secondary spillway
(X) Other service spillway
Name ≈ 230' concrete lined

2. On a separate sheet, draw a plan of the spillway and one or more cross-sections of the spillway which show dimensions, location of concrete sills, etc. Show the elevation of the top of the dam in relation to the spillway crest. Describe features not adequately shown on the sketch. Attach photos.



3. Is there any evidence of erosion?

Yes	No	N/A	Can't Tell	
( )	( )	(X)	( )	Spillway floor
( )	(X)	( )	( )	Spillway side slopes
( )	(X)	( )	( )	Around control sill
(X)	( )	( )	( )	~~Around spillway gates or control structure~~

Other. Explain adjacent to downstream end of spillway slab. Rock has been placed in eroded areas.

Give your opinion of the seriousness of the erosion.

( ) Unlikely that it will become a problem in the forseeable future
( ) May or may not become a problem
( ) Is a problem but not likely to lead to failure

( ) Is a problem which if not corrected could lead to failure
( ) Is a serious problem which could lead to failure at any time
(X) Other
Explain Is not a problem now to the spillway slab, but may casue future problems and should be monitored. Will probably require minor intermittent maintenance.

4. Describe the material in which the spillway is constructed. Estimate the uniform soil classification if in soil or type of rock and formation if in rock.

Shales and limestone

5. Check all the applicable items which describe the spillway.

( ) Gated spillway
(X) Lined with concrete or slope protection
( ) Concrete control sill
( ) Unlined in soil
( ) Unlined in rock

Remarks Plunge pool over Ls and shale to tributary valley floor with about 44' drop onto a 2' thick limestone level.

6. Are there any spillway gates?

(X) No
( ) Yes (Form _____ inclosed)
( ) Yes (Form _____ not inclosed)
Explain

7. Give your opinion of the general condition of the spillway.

Spillway appears to be in good condition.

8. Are there any obstruction to flow through the spillway? (U.S. or D.S)
( ) Yes (X) No

Describe _____

9. In your opinion would a spillway discharge have a tendancy to erode the embankment?

(X) No
( ) Yes
Describe _____

10. In your opinion, is there something about the spillway that warrants special consideration in deciding whether or not to make a more detailed investigation? (X) No ( ) Yes

If yes, why? Also, what specific questions do you think should be answered by this investigation?

11. As a long-range project, recommend clean out and slush grouting of open joints in limestones below spillway slab, possibly supplemented with rock bolting and reinforced gunite. Long term erosion will eventually result in loss of roadway, unless checked.

Surface Condition of Concrete
(from ACI Report 65-67)

1. Identify the feature for which this section applies. (61' wide slot x 7' deep at inlet)
U type spillway (35' wide slot x 5.5' deep at outlet)
(Walls approximately 240' long)

2. General condition of concrete.

(X) Good
( ) Satisfactory
( ) Poor
Remarks _____

3. Cracks. (X) Yes ( ) No

Direction
- (X) Longitudinal
- ( ) Transverse
- (X) Vertical
- ( ) Diagonal
- ( ) Random

Width
- (X) Fine (less than 1 mm)(1/32") (.03")
- ( ) Medium
- ( ) Wide (more than 2 mm) (5/64") (.06")

Type
- ( ) Pattern Cracking
- ( ) Checking
- (X) Hairline cracking
- ( ) D-cracking

Mineralization
- ( ) leaching
- ( ) efflorescence
- ( ) deposition

Describe. (Sketch or include photo if significant) 4'+long vertical hairline cracks above 8 of the tile drains in the wall. A few longitudinal hairline cracks in the middle of the spillway floor at the entrance.

4. Scaling. ( ) Yes (X) No
Describe (depth & extent) _____

Severity
( ) Moderate (no loss of C.A.)
( ) Severe (loss of C.A.)
(Give depth of scaling) _____

5. Exposed steel. ( ) Yes (X) No
Separately describe and photograph each area.
Agent: ( ) Corrosion ( ) Erosion ( ) Spalls ( ) Other
Location: _____
Extent: _____ Depth: _____
Condition: ( ) Good ( ) Fair ( ) Poor ( ) Disintegrated/Missing
Type: ( ) Rebar ( ) Beam ( ) Plate ( ) Mesh ( ) Other

Remarks (location, extent, depth): _____

6. Spalls. ( ) Yes (X) No

Size
( ) Small (less than 2 cm deep and 15 cm long)
( ) Large

Describe _____

7. Is (are) there any:

( ) Honeycomb (X) None
( ) Stains
( ) Popouts
( ) Previous patching or other repair
( ) Chemical attach

Describe _____

8. In your opinion, what is the effect of the condition of the concrete on the safety of the dam?

(X) Little or none
( ) May create operational problems, but no safety problem
( ) If uncorrected, could eventually become a safety problem
( ) It is a safety problem that could result in a large uncontrolled release of water
( ) Other
Explain _____

_____

_____

Remarks _____

_____

_____

_____

Site Geology

1. Does dam or lake abut a narrow (less than 1000') ridge?

(X) Yes ( ) No both, at higher levels

2. Is there any evidence of where the material for the embankment came from?

(X) No
( ) Yes
Describe location and probable material type (unified soils classification system) Probably most from US valley alluvium - reworked glacial and residual soils - gravelly clays (GC) to Lean Clays (CL-B&C).

3. Is there any evidence of rapid erosion (deep, narrow, watercourse)?

(X) Upland
(X) Valleywalls/hillsides
( ) Valley
Describe Upland in loess and glacial CL-ML materials. Valley walls generally at drainage concentrations.

4. Is there any evidence of sliding or slumping in natural soil or rock?

(X) No
( ) Yes
Describe none in immediate area

5. Are there any sinkholes or surface depressions?
(X) No
( ) Yes
Describe None noted, however, surficial bedrock units have wide, solutioned joints and occasional small, filled, cones ≈ sinkholes.

6. Are there open or solutioned joints/bedding planes?

( ) No
(X) Yes
Describe All limestone units have joints from fine to 2± wide (surficial units). Seepage from joints, and from bedding planes in both limestone and shale.

7. Does normal lake level appear to be related to geology rather than to control structures, ie.: limestone, sandstone or pervious soils unit exposed at water level along shoreline?

( ) No
(X) Yes
Describe. Include height below top of dam, spillway and outlet works intake. Limestone and shale from end of SW slab @ 13' below TOD to 29' below TOD. Seepage from Ls units in both abutments, collected in ponds and pumped back.

8. Do any exposed bedrock members, below top of dam, have soft clay seams?

( ) No
(X) Yes
Describe (thickness, height below top of dam, statigraphic relationships). Sketch if necessary. Shales generally <1 ft. thick below/ between limestones from SW slab to top of Bonner Springs shale @ 29 ft. below TOD. See attached measured geological section in SW channel (DS).

9. Describe any other geologic conditions affecting the water control structures. Unless positive cutoff would except underseepage in valley gravels (basal).

10. In your opinion, is there anything about the geology that warrants special consideration in deciding whether or not to perform a more detailed investigation? (X) Yes ( ) No

If yes, why? Also, what specific questions do you feel the investigation should attempt to resolve? Considerable abutment seepage (400± gpm, Rt and not estim. Lt). Should correlate flows with weirs and monitor continually. Right abutment (seepage) should be grouted. Should also check underseepage using alluvial and bedrock PZ's.

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

1. The hydrologic analysis is based on applying a design storm to a unit hydrograph to obtain the inflow hydrograph for the reservoir routing. The unit hydrograph is developed using Snyder's method outlined in EM 1110-2-1405 (Flood Hydrograph Analyses and Computations). The design storm for those dams in the high hazard potential category is derived from the probable maximum precipitation as determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." A 24-hour storm duration is assumed with the 24-hour rainfall amounts reduced to six-hour values in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum six-hour rainfall is reduced to smaller time increments based on a storm distribution as proposed by the SCS in their hydrology handbook. The remaining six-hour rainfall amounts are divided into equal values corresponding to the unit hydrograph duration. Runoff values are obtained by reducing the rainfall amounts by applicable initial and infiltration losses. The Probable Maximum Flood (PMF) hydrograph is derived by applying the runoff values to the unit hydrograph. The resulting PMF hydrograph is then used as the inflow hydrograph for a reservoir routing.

2. The reservoir routing is accomplished by using a standard routing technique wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves. The program offers several options for development of the above curves.

3. If the dam is overtopped by the PMF hydrograph, the PMF hydrograph ordinates are incrementally reduced by ten percent until the dam is no longer overtopped. This computation determines the percentage of the PMF hydrograph that can be routed through the reservoir without the dam being overtopped.

Waukomis Lake

Basin Description. Waukomis Lake is located on an unnamed tributary to Line Creek in Section 17, Range 33 West, Township 51 North, 1 mile east of Platte Woods, Missouri. From a USGS topographic map the drainage area is 1.9 square miles with a normal lake area of 80 acres. The total length of the basin is 2.0 miles with an average width of 1.0 mile. The topography of the area is characterized by relatively steep hills with about 30 percent of the area urbanized, 20 percent timbered, and 50 percent in grass land. The entire perimeter of the lake is occupied by residential housing. Elevations in the basin range from 1080 ft., m.s.l., at the headwaters to 880 ft., m.s.l., at the dam, resulting in an average slope of 100 feet per mile. Runoff from the area will reach the lake relatively fast due to the degree of urbanization and the number of tributaries feeding the lake.

From the standpoint of dam safety, the hydrologic design of the dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of water over the crest will erode the dam face and, if continued long enough, will breach the dam embankment and release all the stored waters suddenly into the downstream flood plain. The safe hydrologic design of a dam calls for a spillway discharge capability, in combination with an embankment crest height, that can handle a very large and exceedingly rare flood without overtopping the embankment.

The technical hydrologic analysis for Waukomis Lake is presented on Plates 1 through 4. As shown on Plate 4, the dam is overtopped by 1.3 feet by the PMF event, with a total duration of overflow of about 3 hours. Information on Plate 4 also indicates that the embankment can contain an event equal to approximately 70 percent of the PMF.

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IROLOGIC ANALYSIS OF DAMS- CLARON L KOONTZ. USCE KCD. PHONE   816-374-3651 OR 8-758-3651 (FTS) PROGRAM DATE   12APR78

********** LISTING OF CARD INPUT DATA ********** PAGE   1

LAKE WAUKOMIS-ID NO M010691      7-8-78   RRS
NO ORIGINAL PLANS AVAILABLE
ALL INFO FROM QUAD SHT + COE SURVEY
4
5
.25     1.9     939.
SNYDERS UG
2.0     .9      .63     1.9     .91
PMP STORM
112.    124.    132.    24.5    .40     .03
ELEV-CAP FROM PLANIMETERED AREAS
4.0     7.
990.    0.      910.    89.     930.    713.    939.    1312.   945.    1878.
950.    2490.   960.    4076.
SPWY RATING BY CRITICAL DEPTH
1.0             939.    61.     .00001
TOP OF DAM X-SEC USED TO COMPUTE RATING CURVE BY CRITICAL DEPTH METHOD
1.0     8.      946.    785.
-35.    950.    0.      946.5   74.     946.6   323.    946.0   498.    946.8
679.    947.0   786.    947.2   787.    950.
NO OUTLET PRESENT THROUGH DAM
0.
FINISHED
```

4 INSPECTION HYDROLOGIC ANALYSIS - SUMMARY OF UNIT HYDROGRAPH ORDINATES AND RAINFALL, LOSS AND EXCESS

LAKE WAUKOMIS-ID NO MO10691 7-8-78 RRS
NO ORIGINAL PLANS AVAILABLE
ALL INFO FROM QUAD SHT + COE SURVEY
4
5

SNYDERS .250 HOUR UNIT HYDROGRAPH ORDINATES IN CFS AT .250 HOUR INTERVALS BEGINNING AT ZERO TIME

0.0	191.6	383.1	672.3	783.5	662.7	513.1	393.0	341.4	289.7	238.1	186.5
134.8	83.2	31.6	0.0								

PROBABLE MAXIMUM RAINFALL, LOSSES AND EXCESS FOR SUCCESSIVE .250 HOUR PERIODS.

.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028
.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028	.028
.028	.028	.017	.008	.008	.008	.008	.008	.008	.008	.008	.008
0.000	0.000	.010	.020	.020	.020	.020	.020	.020	.020	.020	.020
.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091
.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098	.098
.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091	.091
.549	.220	.549	.439	.659	.549	1.142	.834	4.281	3.951	1.207	.988
.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
.541	.212	.541	.432	.651	.541	1.134	.827	4.273	3.944	1.200	.980
.988	.871	.549	.549	.549	.549	.439	.439	.439	.439	.329	.439
.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
.980	.871	.541	.541	.541	.541	.432	.432	.432	.432	.322	.432
.038	.038	.038	.038	.038	.038	.038	.038	.038	.038	.038	.038
.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030
.038	.038	.038	.038	.038	.038	.038	.038	.038	.038	.038	.038
.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008	.008
.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030	.030

DAM INSPECTION HYDROLOGIC ANALYSIS - LAKE ELEVATIONS, STORAGES AND DISCHARGE RATING TABLES

LAKE WAUKOMIS-ID NO MO10691 7-8-78 RRS

LAKE ELEVATION FT.MSL	LAKE STORAGE AC-FT	STORAGE PLUS HALF DISCHARGE AC-FT	OUTLET DISCHARGE C.F.S.	SPILLWAY DISCHARGE C.F.S.	OVER TOP OF DAM C.F.S.	TOTAL DISCHARGE C.F.S.
951.000	2616.399	2932.916	0.000	7832.372	22806.031	30638.403
950.000	2490.000	2720.517	0.000	6868.783	15444.982	22313.765
949.000	2353.695	2509.019	0.000	5952.575	9082.509	15035.084
948.000	2224.720	2317.522	0.000	5087.273	3895.816	8983.090
947.000	2102.687	2155.447	0.000	4257.305	849.788	5107.093
946.000	1987.230	2023.208	0.000	3482.643	.000	3482.643
945.000	1878.000	1906.607	0.000	2769.160	0.000	2769.160
944.000	1769.311	1790.994	0.000	2098.957	0.000	2098.957
943.000	1666.806	1682.281	0.000	1497.949	0.000	1497.949
942.000	1570.141	1580.256	0.000	979.046	0.000	979.046
941.000	1478.988	1484.374	0.000	521.356	0.000	521.356
940.000	1393.039	1394.628	0.000	153.845	0.000	153.845
939.000	1312.000	1312.000	0.000	.000	0.000	.000
938.000	1226.401	1226.401	0.000	0.000	0.000	0.000
937.000	1146.303	1146.303	0.000	0.000	0.000	0.000
936.000	1071.360	1071.360	0.000	0.000	0.000	0.000
935.000	1001.244	1001.244	0.000	0.000	0.000	0.000
934.000	935.649	935.649	0.000	0.000	0.000	0.000
933.000	874.288	874.288	0.000	0.000	0.000	0.000
932.000	816.892	816.892	0.000	0.000	0.000	0.000
931.000	763.208	763.208	0.000	0.000	0.000	0.000
930.000	713.000	713.000	0.000	0.000	0.000	0.000
929.000	643.233	643.233	0.000	0.000	0.000	0.000
928.000	580.228	580.228	0.000	0.000	0.000	0.000
927.000	523.336	523.336	0.000	0.000	0.000	0.000
926.000	471.970	471.970	0.000	0.000	0.000	0.000
925.000	425.598	425.598	0.000	0.000	0.000	0.000
924.000	383.740	383.740	0.000	0.000	0.000	0.000
923.000	345.959	345.959	0.000	0.000	0.000	0.000
922.000	311.863	311.863	0.000	0.000	0.000	0.000
921.000	281.096	281.096	0.000	0.000	0.000	0.000
920.000	253.335	253.335	0.000	0.000	0.000	0.000
919.000	228.290	228.290	0.000	0.000	0.000	0.000
918.000	205.698	205.698	0.000	0.000	0.000	0.000
917.000	185.321	185.321	0.000	0.000	0.000	0.000
916.000	166.943	166.943	0.000	0.000	0.000	0.000
915.000	150.371	150.371	0.000	0.000	0.000	0.000
914.000	135.428	135.428	0.000	0.000	0.000	0.000
913.000	121.956	121.956	0.000	0.000	0.000	0.000
912.000	109.812	109.812	0.000	0.000	0.000	0.000
911.000	98.865	98.865	0.000	0.000	0.000	0.000
910.000	89.000	89.000	0.000	0.000	0.000	0.000
909.000	56.753	56.753	0.000	0.000	0.000	0.000
908.000	36.172	36.172	0.000	0.000	0.000	0.000
907.000	23.043	23.043	0.000	0.000	0.000	0.000
906.000	14.672	14.672	0.000	0.000	0.000	0.000

\M INSPECTION HYDROLOGIC ANALYSIS - SUMMARY TABLE

LAKE WAUKOMIS-ID NO M010691 7-8-78 RRS
NO ORIGINAL P.ANS AVAILABLE
ALL INFO FROM QUAD SHT + COE SURVEY
&
S

SYNDERS .250 HOUR UNIT HYDROGRAPH DATA AND PARAMETERS

DURATION HOURS	DA SQ-MI	L MILES	LCA MILES	CP	CT	QP C.F.S	TP HOURS	W50 HOURS	W75 HOURS	UNIT VOL AC-FT
.250	1.90	2.00	.90	.630	.763	822.7	.91	1.11	.64	101.33

PROBABLE MAXIMUM STORM PRECIPITATION AND RUNOFF CHARACTERISTICS

PMP INDEX	RAIN FACTOR	DISTRIBUTION IN PERCENT OF PMP 6-HR	12-HR	18-HR	24-HR	INT-LOS INCHES	INF-RATE INCH/HR	VOLUME IN INCHES RAIN	LOSS	EXCESS
24.50	.800	112.00	124.00	128.62	132.00	.40	.03	25.87	1.01	24.86

LAKE INFLOW HYDROGRAPH ORDINATES

PROBABLE MAXIMUM FLOOD HYDROGRAPH ORDINATES IN CFS AT .250 HOUR INTERVALS BEGINNING AT ZERO TIME

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	2.0	7.8	18.5	33.2	47.7	59.5	68.5	75.9	82.2
87.5	105.3	135.5	185.0	241.3	288.2	324.3	352.0	376.0	396.4	413.2	426.3
435.8	441.6	443.9	443.9	443.9	443.9	443.9	443.9	443.9	443.9	443.9	443.9
443.9	530.2	639.8	879.9	1116.8	1378.9	1639.3	1998.8	2385.8	3477.6	5113.7	7024.6
8588.4	8815.1	8159.4	7333.2	6689.4	6114.6	5506.5	4909.7	4335.1	3763.2	3203.5	2719.9
2438.7	2203.9	1946.9	1627.7	1293.2	1019.9	804.9	643.7	508.9	398.3	308.4	239.3
190.8	160.9	148.2	148.2	148.2	148.2	148.2	148.2	148.2	148.2	148.2	148.2
148.2	142.4	130.9	110.5	86.9	66.8	51.3	39.4	29.1	20.4	13.2	7.5
3.5	1.0	0.0	0.0								

LAKE AND DAM INFORMATION

BEGINNING POOL ELEV FT.MSL	OUTLET INVERT FT.MSL	BOTTOM OF LAKE FT.MSL	SPILLWAY CREST FT.MSL	SPILLWAY CREST WIDTH FEET	TOP OF DAM ELEVATION FT.MSL	TOP OF DAM LENGTH FEET	HEIGHT OF DAM FEET	DOWNSTREAM SLOPE OF DAM	N-VALVE ON DS SLOPE	COEF OF FLOW OVER DAM
939.00	0.00	890.00	939.00	61.0	946.00	785.0	~~56.0~~ 71	1V ON ~~3.00H~~ 2H	.030	2.90

SUMMARY OF FLOOD ROUTINGS OF INFLOW HYDROGRAPH THROUGH THE LAKE

ROUTING NUMBER	PERCENT PMF INFLOW HYDROGRAPH	TOTAL INFLOW VOLUME AC-FT	MAXIMUM LAKE ELEVATION FT.MSL	DEPTH OF LAKE OVER TOP OF DAM FEET	ESTIMATED VELOCITIES CREST FPS	TOE FPS	INITIAL TIME TO OVER TOP HOUR	TOTAL TIME OVER DAM HOURS	VOLUME SPILLED OVER DAM AC-FT	MAXIMUM DISCHARGE FROM DAM CFS
1	100.0	2519.	947.33	1.33	5.34	13.36	15.53	2.89	386.6	6380.2
2	90.0	2267.	947.04	1.04	4.73	11.57	15.70	2.50	230.5	5278.6
3	80.0	2015.	946.58	.58	3.52	8.10	15.96	1.91	97.2	4420.0
4	70.0	1763.	946.04	.04	.98	1.75	16.67	.55	2.2	3555.4
5	60.0	1512.	945.29	-.71	0.00	0.00	0.00	0.00	0.0	2972.9

PLATE 7

MISSOURI RIVER DIVISION
MISSOURI CONT'D
PLATTE COUNTY CONT'D

INVENTORY OF DAMS 1976

KANSAS CITY DISTRICT

IDENTIFICATION STATE	IDENTIFICATION NUMBER	DIV	PRINCIPAL ST	PRINCIPAL COUNTY	PRINCIPAL CONG DIST	SECONDARY ST	SECONDARY COUNTY	SECONDARY CONG DIST	OFFICIAL DAM NAME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	REPORT DATE	POPULAR DAM NAME
MO	10647	LMV	MO	165	06				JAMES F PORTER DAM	39	17.3	094	49.8	03MAY74	

NAME OF IMPOUNDMENT	REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY--TOWN--VILLAGE	DIST FROM DAM	POPULATION	TYPE OF DAM
JAMES F PORTER LAKE	10	30	TR PLATTE RIVER	FARLEY	001	00000174	RE

YEAR COMP	PURPOSES	HEIGHT STRUCT	HEIGHT HYDR	IMPOUNDING CAPACITIES MAXIMUM	IMPOUNDING CAPACITIES NORMAL	REMARKS	D/S HAZ	CREST LENGTH
1965	D	0025	0025	0000[illegible]30	00000026	24 25 26 27 ESTIMATED		

SPILLWAY TYPE	SPILLWAY WIDTH	SPILLWAY DISCHARGE	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT)	WIDTH (FT)	LENGTH (FT)	WIDTH (FT)	LENGTH (FT)	WIDTH (FT)	LENGTH (FT)	WIDTH (FT)	OWNER	ENGINEERING BY
															JAMES F PORTER	

CONSTRUCTION BY	REGULATORY AGENCY DESIGN	REGULATORY AGENCY CONSTRUCTION	REGULATORY AGENCY OPERATION	REGULATORY AGENCY MAINTENANCE	INSPECTION BY

INSPECTION DATE	AUTHORITY FOR INSPECTION	REMARKS
		SURFACE 3 ACRES WATERSHED 139 ACRES

MISSOURI CONT'D
PLATTE COUNTY CONT'D

KANSAS CITY DISTRIC

IDENTIFICATION STATE	IDENTIFICATION NUMBER	DIV	PRINCIPAL ST	PRINCIPAL COUNTY	PRINCIPAL CONG DIST	SECONDARY ST	SECONDARY COUNTY	SECONDARY CONG DIST	OFFICIAL DAM NAME	LATITUDE DEG	LATITUDE MIN	LONGITUDE DEG	LONGITUDE MIN	REPORT DATE	POPULAR DAM NAME
MO	10691	LMV	MO	165	06				LAKE WAUKOMIS DAM	39	13.7	094	38.0	14SEP73	

NAME OF IMPOUNDMENT	REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY--TOWN--VILLAGE	DIST FROM DAM	POPULATION	TYPE OF DAM
WAUKOMIS LAKE	10	30	LINE CREEK	WAUKOMIS	001	0000110[illegible]	RE

YEAR COMP	PURPOSES	HEIGHT STRUCT	HEIGHT HYDR	IMPOUNDING CAPACITIES MAXIMUM	IMPOUNDING CAPACITIES NORMAL	REMARKS	D/S HAZ	CREST LENGTH
1965	D	0025	0025	0[illegible]0	00001913	24 25 26 27 ESTIMATED		

SPILLWAY TYPE	SPILLWAY WIDTH	SPILLWAY DISCHARGE	VOLUME OF DAM (CY)	POWER CAPACITY INSTALLED (MW)	POWER CAPACITY PROPOSED (MW)	NAVIGATION LOCKS NO	LENGTH (FT)	WIDTH (FT)	LENGTH (FT)	WIDTH (FT)	LENGTH (FT)	WIDTH (FT)	LENGTH (FT)	WIDTH (FT)	OWNER	ENGINEERING BY
															CITY OF WAUKOMIS	

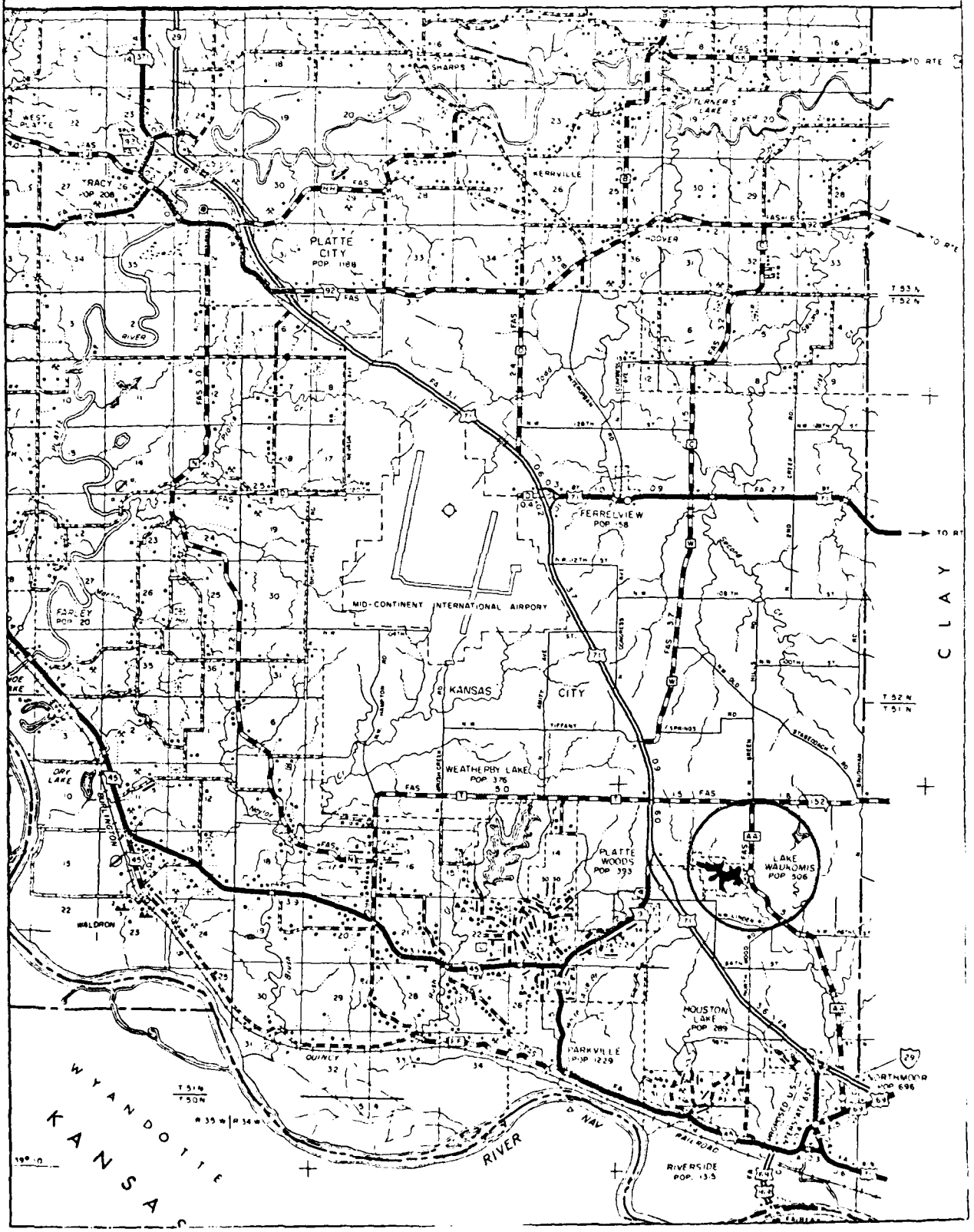
CONSTRUCTION BY	REGULATORY AGENCY DESIGN	REGULATORY AGENCY CONSTRUCTION	REGULATORY AGENCY OPERATION	REGULATORY AGENCY MAINTENANCE	INSPECTION BY

INSPECTION DATE	AUTHORITY FOR INSPECTION	REMARKS
		SURFACE 82 ACRES WATERSHED 1306 ACRES

U. S. ARMY CORPS OF ENGINEERS - KANSAS CITY DISTRICT

Comp. By RAJ *Date* 7-19-78 *Project* Lake Waukomis Dam ID No. MO 10691

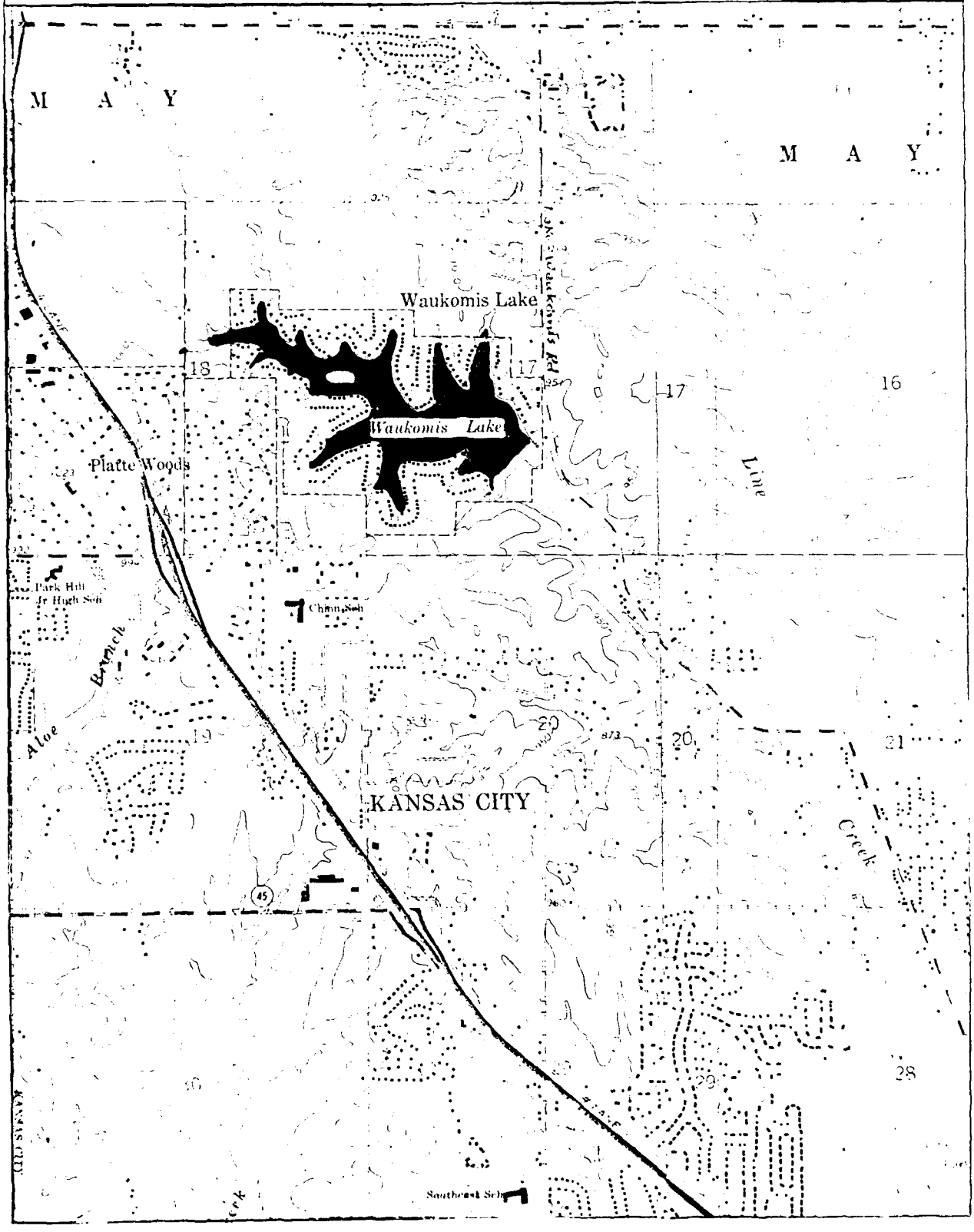
Base Map ID Mo. DOT, Platte County Latest Rev. 1966



U. S. ARMY CORPS OF ENGINEERS - KANSAS CITY DISTRICT

Comp. By RAJ *Date* 7-10-78 *Project* Lake Waukomis Dam ID No. MO 10691

Base Map ID USGS, Parkville & Kansas City North, Missouri Latest Rev. 1975

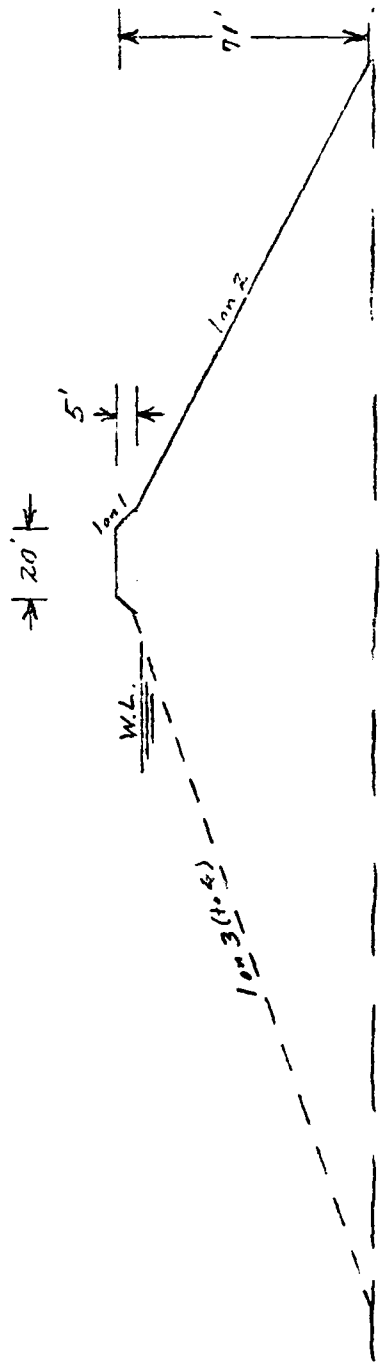


U. S. ARMY CORPS OF ENGINEERS - KANSAS CITY DISTRICT

MO 10691

Comp. By RAJ Date 8-78 Project LAKE WAUKOMIS DAM Sheet ____ of ____

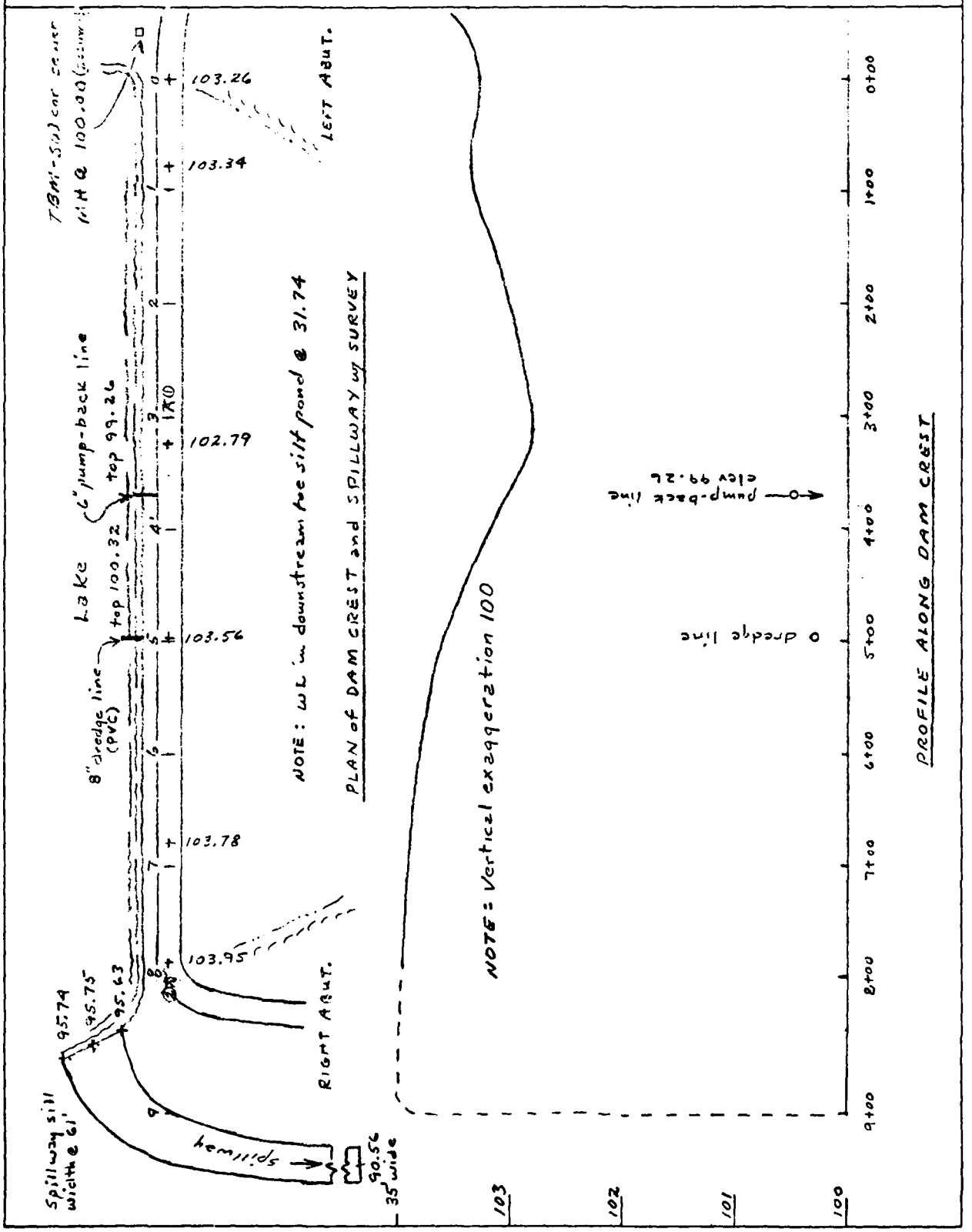
Chkd. By ____ Date ____ Subject Embankment Section Sheet ____ of ____



U. S. ARMY CORPS OF ENGINEERS - KANSAS CITY DISTRICT

Comp. By _____ Date 7-78 Project LAKE WAUKOMIS DAM Sheet ____ of ____

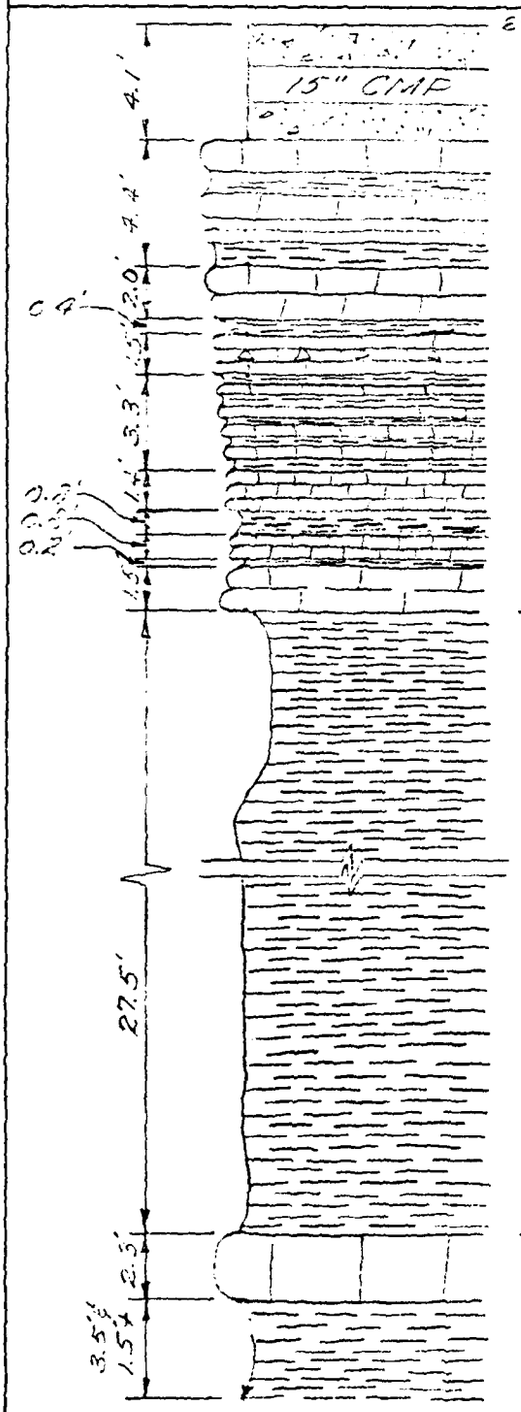
Chkd. By _____ Date _____ Subject MO 10691 Sheet ____ of ____



U. S. ARMY CORPS OF ENGINEERS - KANSAS CITY DISTRICT

Comp. By PAJ Date 6-78 Project LAKE WAUKOMIS DAM Sheet ____ of ____

Chkd. By ____ Date ____ Subject MO 10691 Sheet ____ of ____



PLATTSBURG FORMATION

Spring Hill Limestone - Thin to medium bedded w/ interbedded platy shales, light gray to tan, numerous joints - open.

Hickory Creek Shale - Laminated, gray

Merriam Limestone - Thin to medium bedded w/ laminated gray shale, light gray w/ red-brown mottling lower unit.

Shale - Platy to banded, gray, clay-ironstone nodules lower unit.

BONNER SPRINGS FORMATION

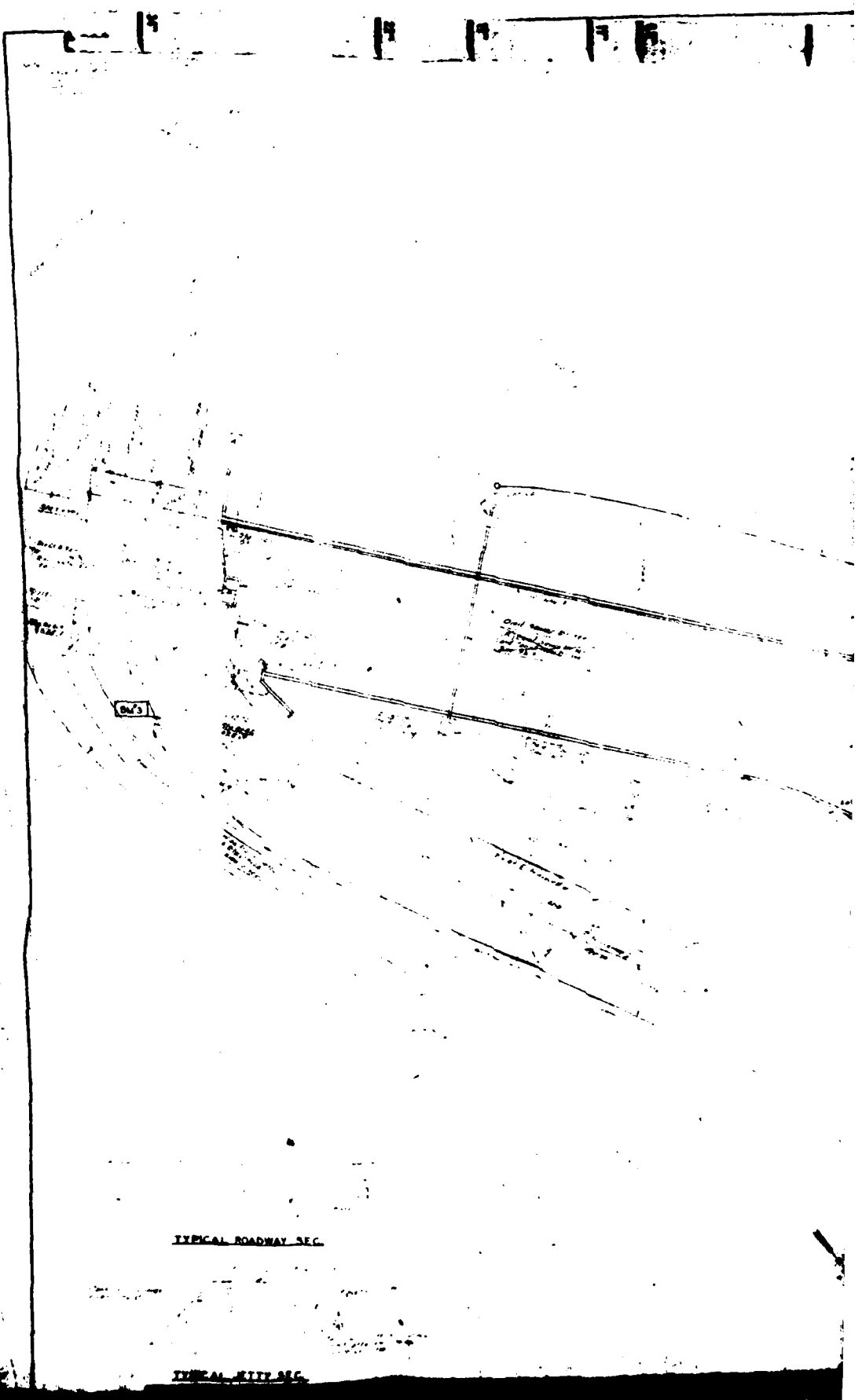
NOTE: Benched 15.5' to 18' up from base.

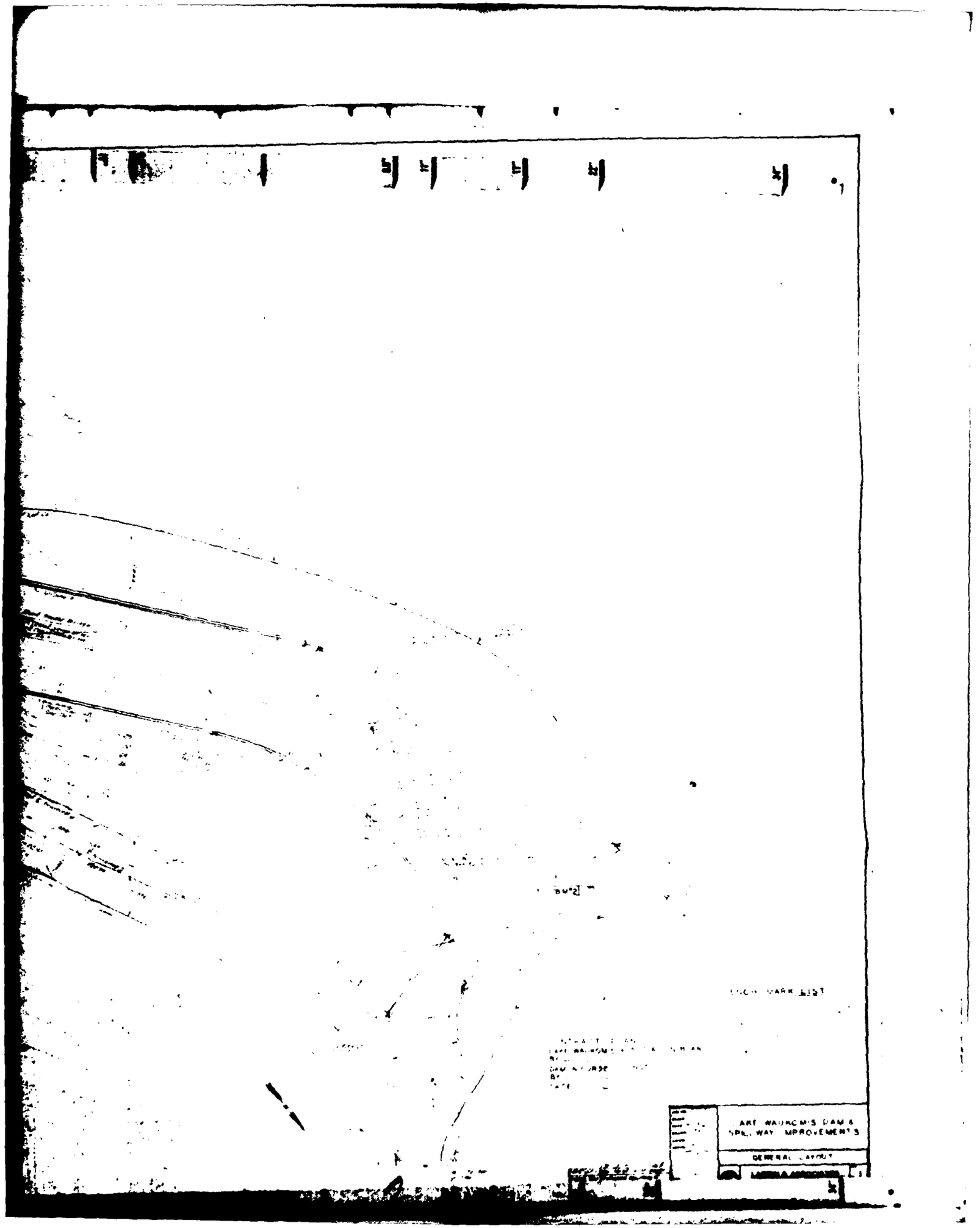
WYANDOTTE Fm.

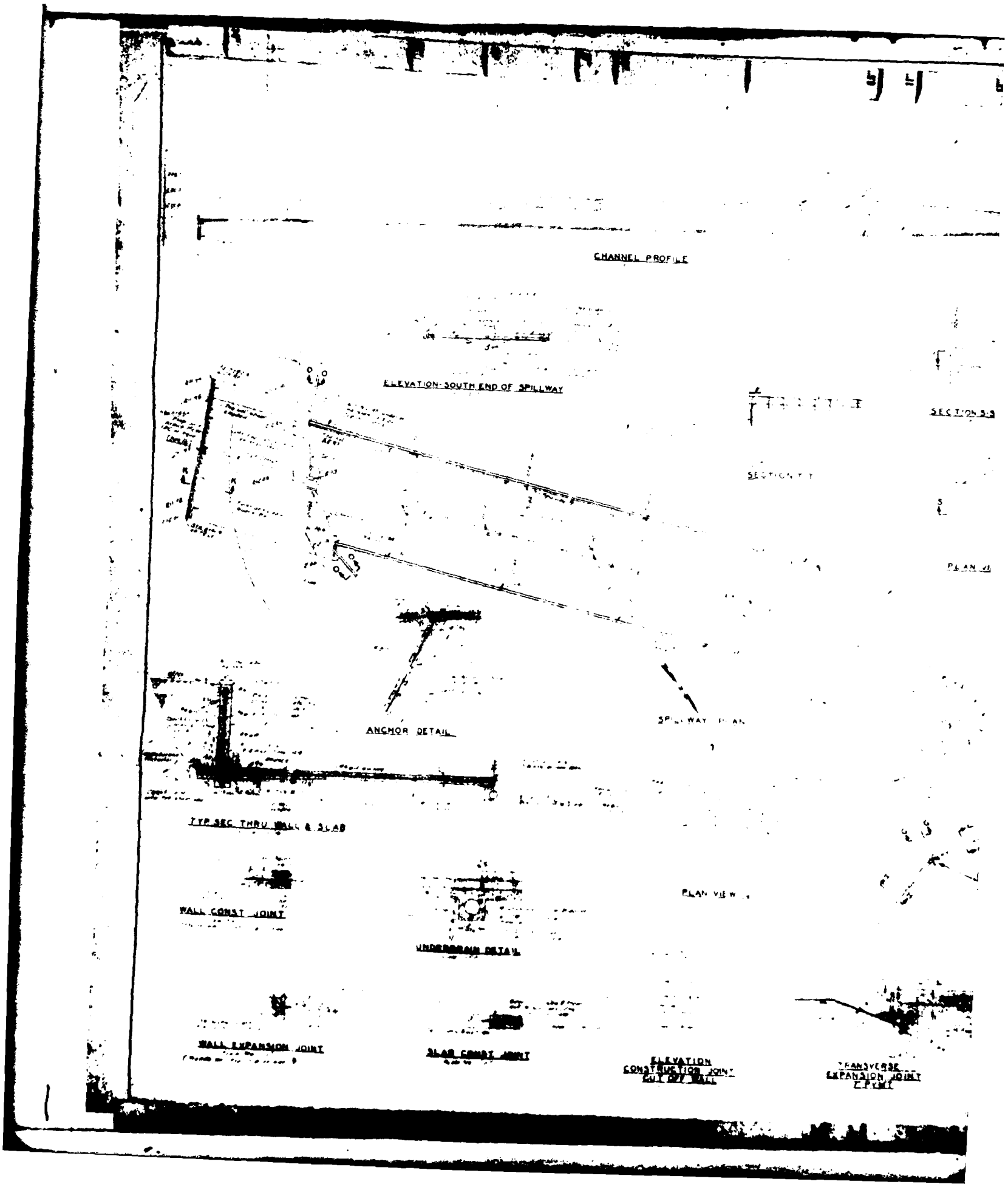
Floor of plunge pool

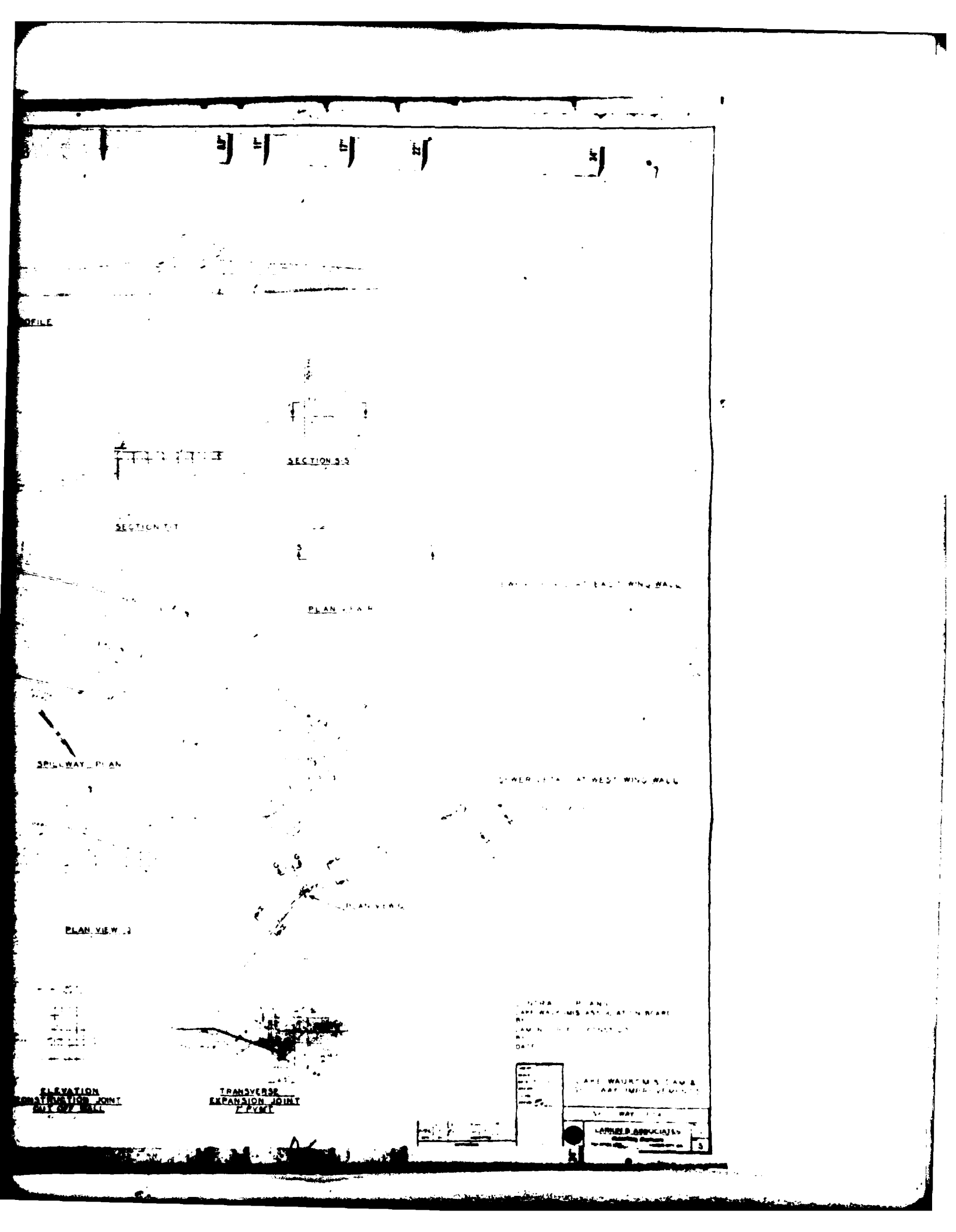
Farley Limestone - Massive, light gray, large joint blocks.

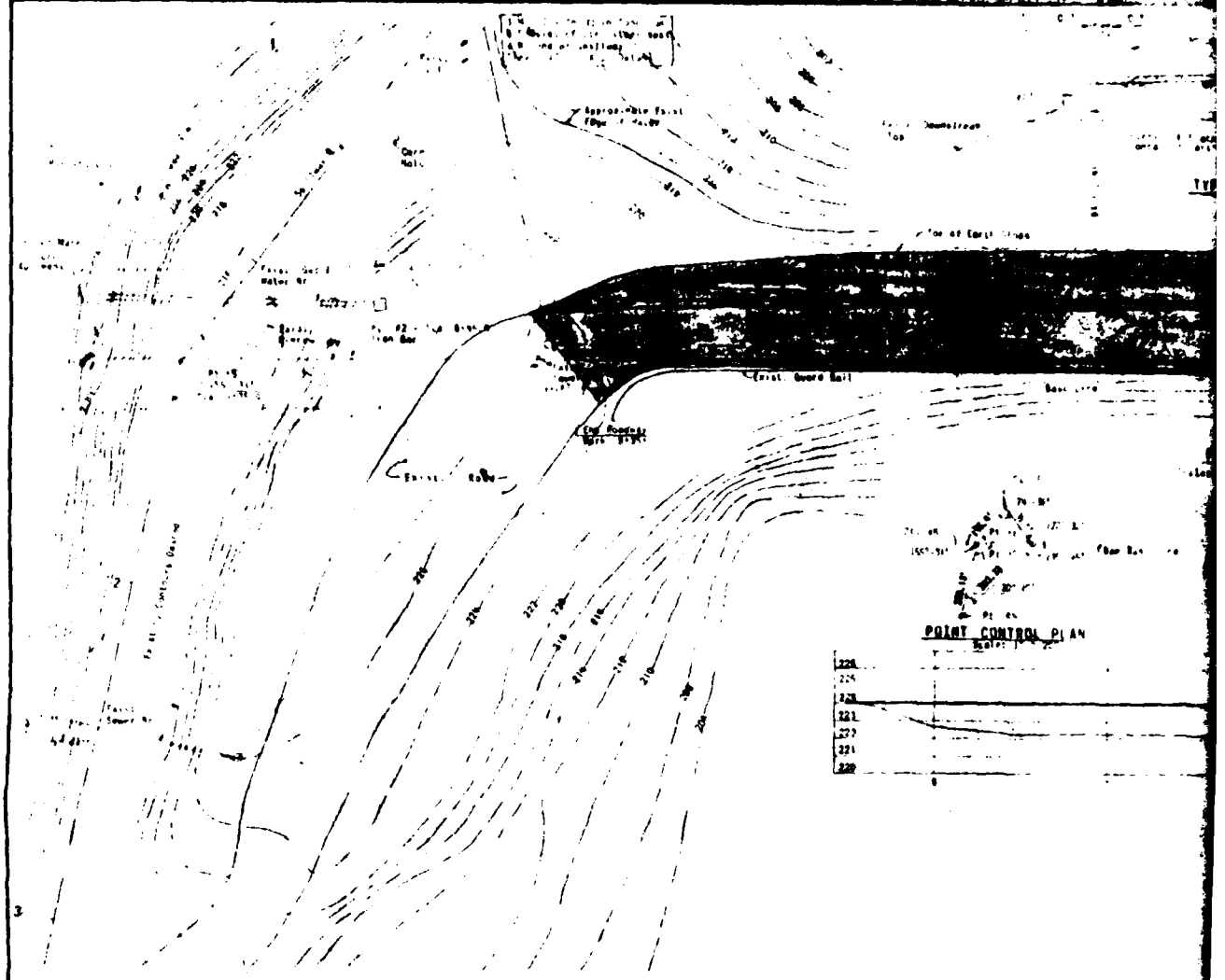
Shale - Platy to blocky, tan-gray, calcareous & argillaceous limestone.


TYPICAL ROADWAY SEC.
TYPICAL UTILITY SEC.

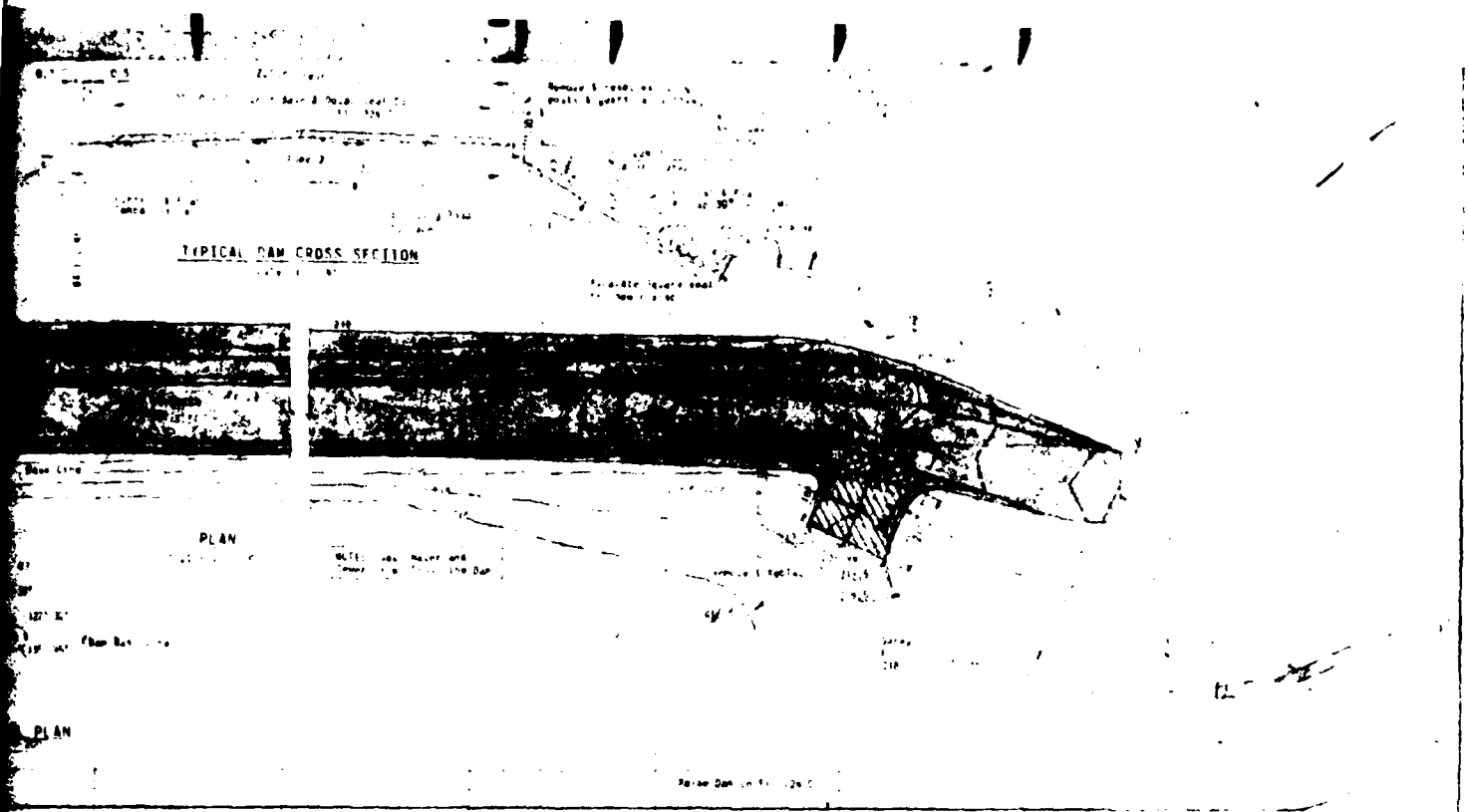

ART WAUKOMIS DAM &
SPILLWAY IMPROVEMENTS
GENERAL LAYOUT

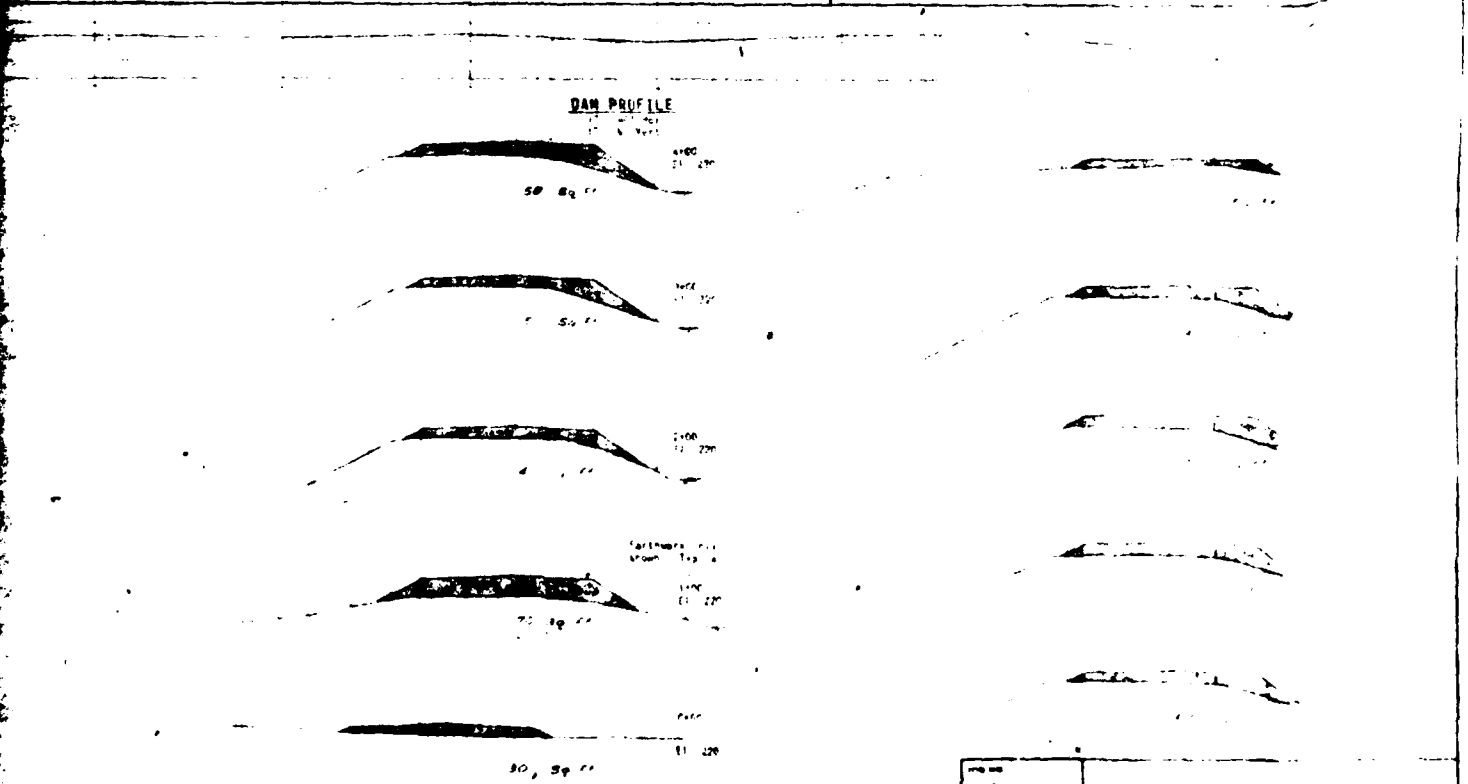

CHANNEL PROFILE
ELEVATION-SOUTH END OF SPILLWAY
SECTION S-S
SECTION T-T
PLAN VI
ANCHOR DETAIL
SPILLWAY PLAN
TYP SEC THRU WALL & SLAB
PLAN VIEW
WALL CONST JOINT
UNDERDRAIN DETAIL
WALL EXPANSION JOINT
SLAB CONST JOINT
ELEVATION
CONSTRUCTION JOINT
TRANSVERSE
EXPANSION JOINT


SECTION S-S
SECTION T-T
PLAN
SPILLWAY PLAN
PLAN VIEW
PLAN VIEW
ELEVATION
CONSTRUCTION JOINT
TRANSVERSE
EXPANSION JOINT



CONTRACT PL
LAKE WAUKOMIS A
BY
DAMON PURSELL
BY
DATE





CONTRACT PLANS
ARE WAUKOMIS ASSOCIATION BOARD

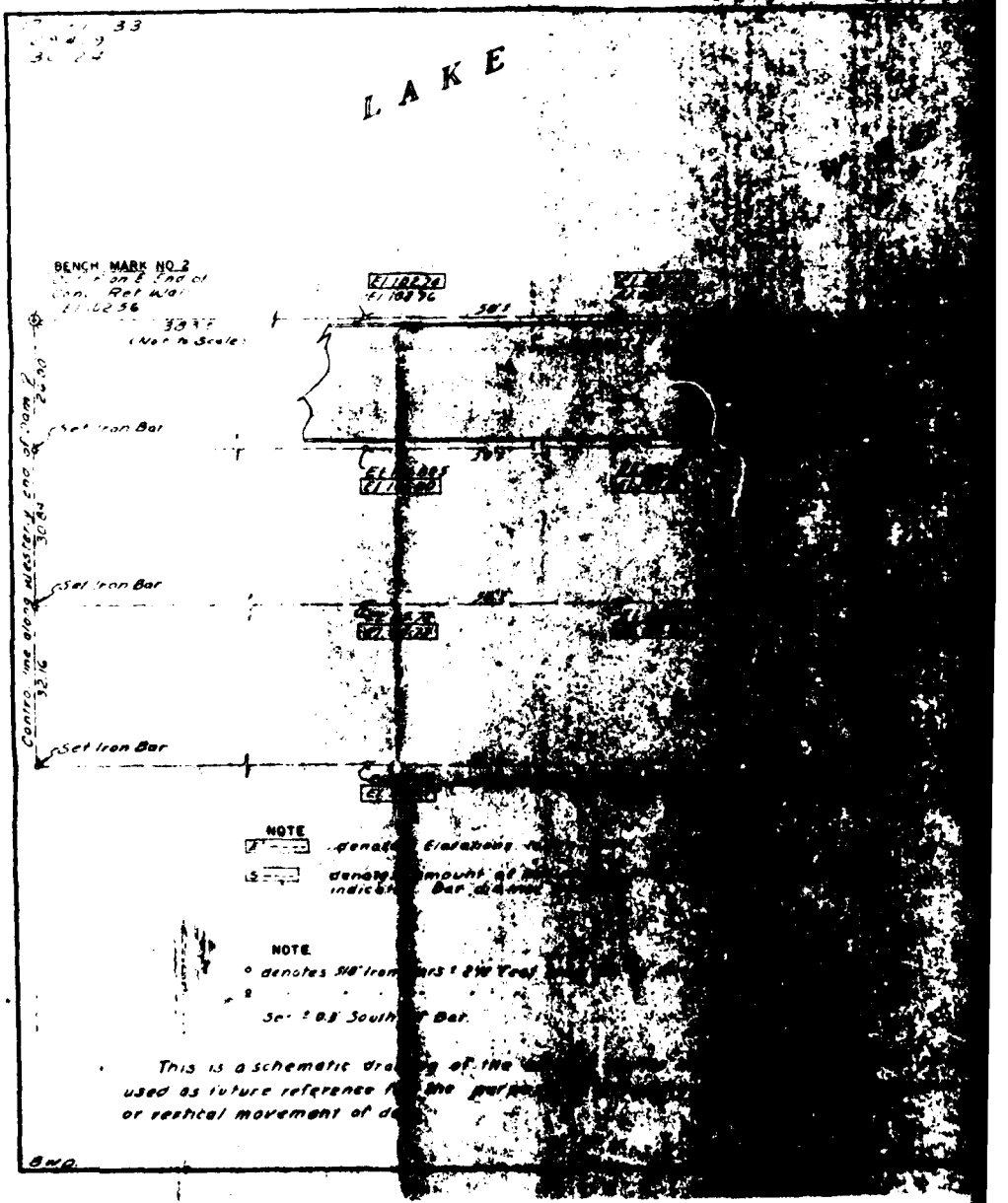
AMON PURSELL CONST CO

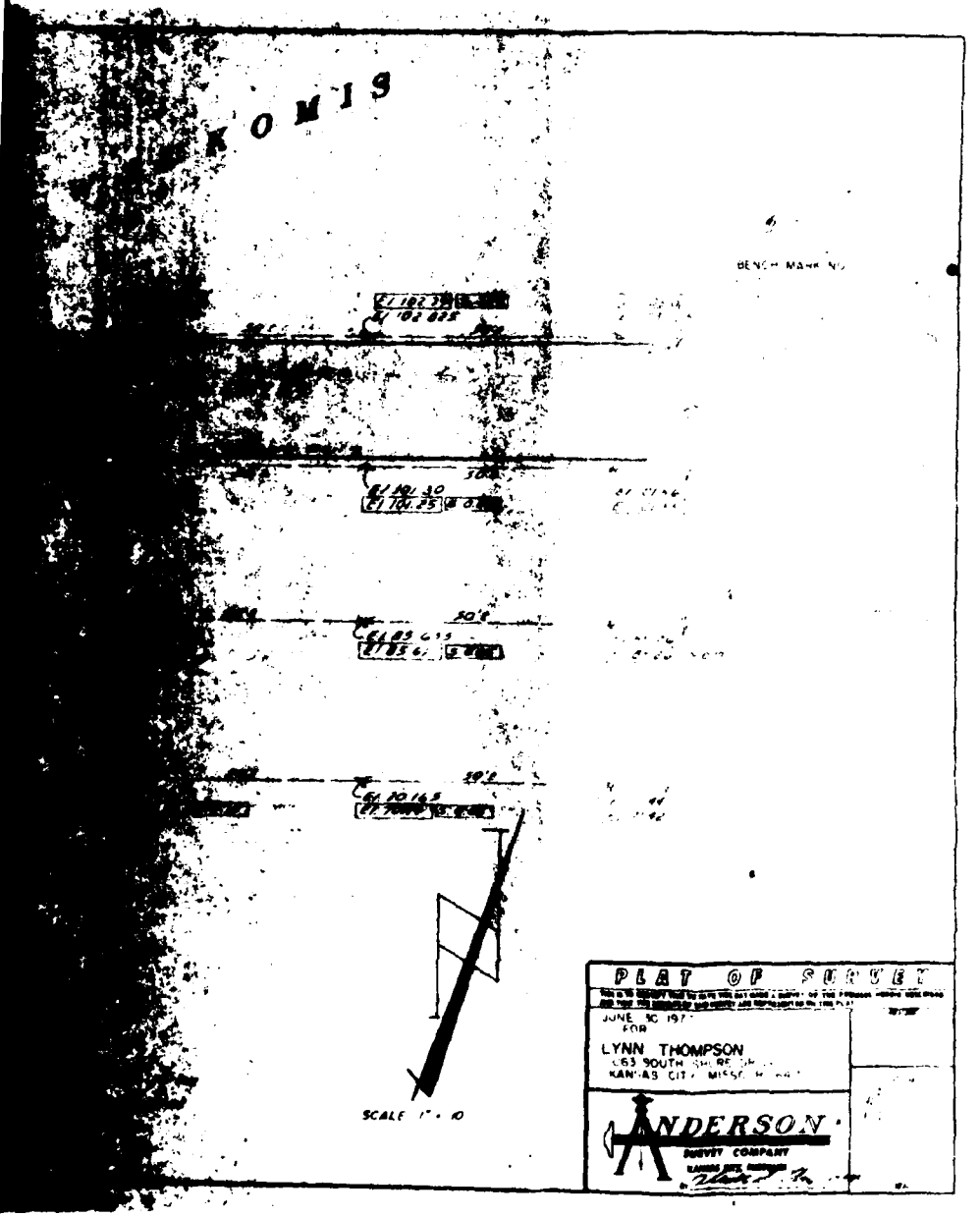
ATE

DAM CROSS SECTIONS

LARKIN & ASSOCIATES
Consulting Engineers

5


LAKE
BENCH MARK NO 2
(Not to Scale)
Set Iron Bar
Set Iron Bar
Set Iron Bar
NOTE
NOTE
This is a schematic
used as future reference
or vertical movement of
BMQ


PLAT OF SURVEY
JUNE 30 197
FOR
LYNN THOMPSON
SCALE 1" = 10
ANDERSON
SURVEY COMPANY

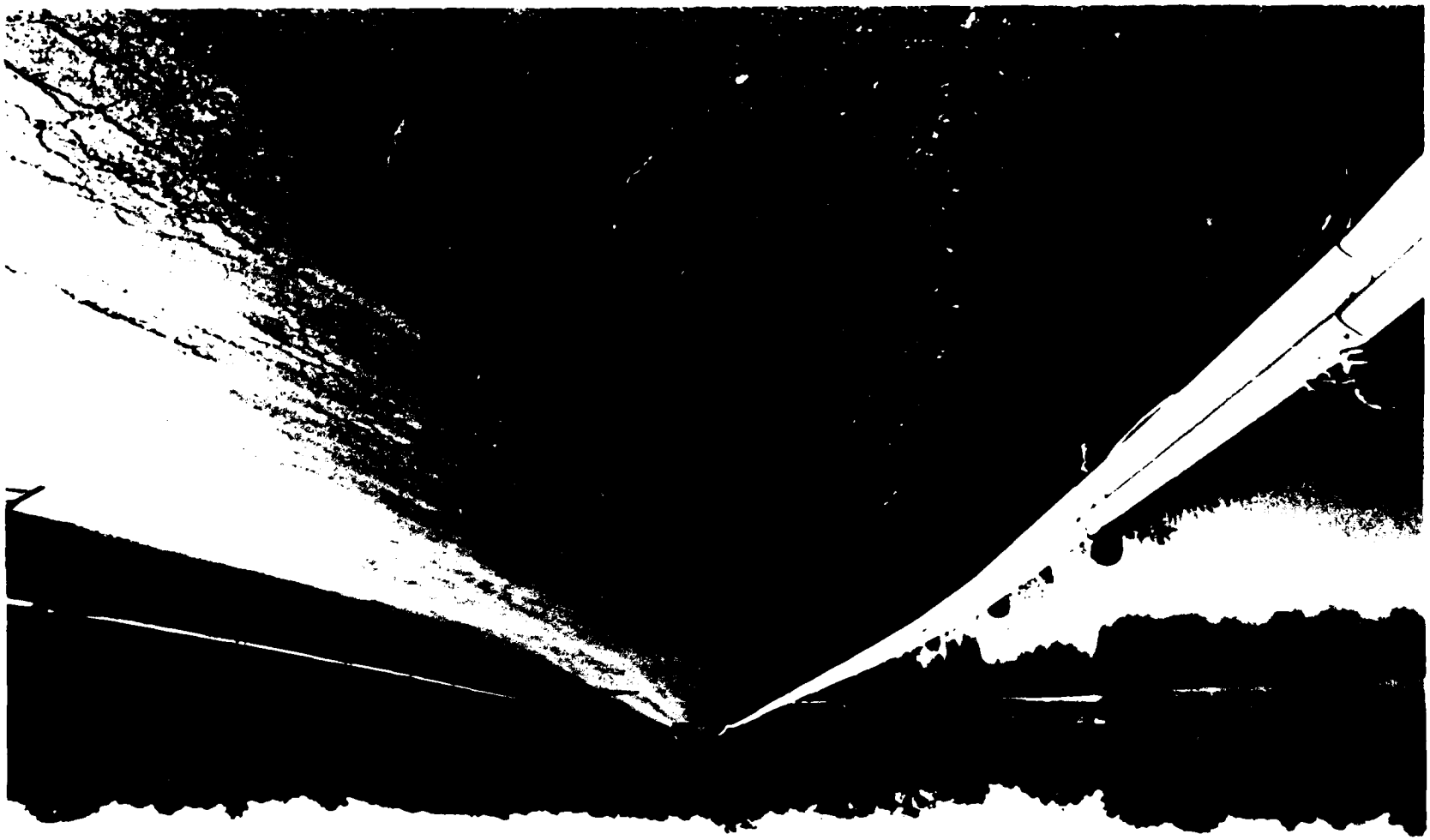
1 2

Photography Log

National Dam Inspection Program

Lake Waukomis
Platte County, Missouri
28 June 1978
Roll 26
Photo No. 1 - DS embankment from Right abutment
2 - Top of dam from Right abutment
3 - US embankment from Right abutment
4 - SW - DS from lake on center line
5 - SW - DS from first CJ DS
6 - SW - US from DS end of slab
7 - SW - DS from DS end of slab
8 - SW - DS end slab from Right DS
9 - SW - plunge pool face
10 - SW - DS channel from plunge pool "L"
11 - Limestone with solutioned joints Right SW with base estimated 2-3' below top of dam
12 - Right abutment point seepage 400± gpm
13 - DS from center top of dam
14 - Right US lake view
15 - Left US lake view
16 - Top of dam from Left abutment (Bob and Ron on slide frac)
17 - US face from Left abutment
18 - DS embankment from Left abutment
19 - DS embankment from toe of dam (center)
20 - DS embankment thru seepage at left center
21 - DS seepage left abutment

Roll 27
Photo No. 1 - Typical riprap



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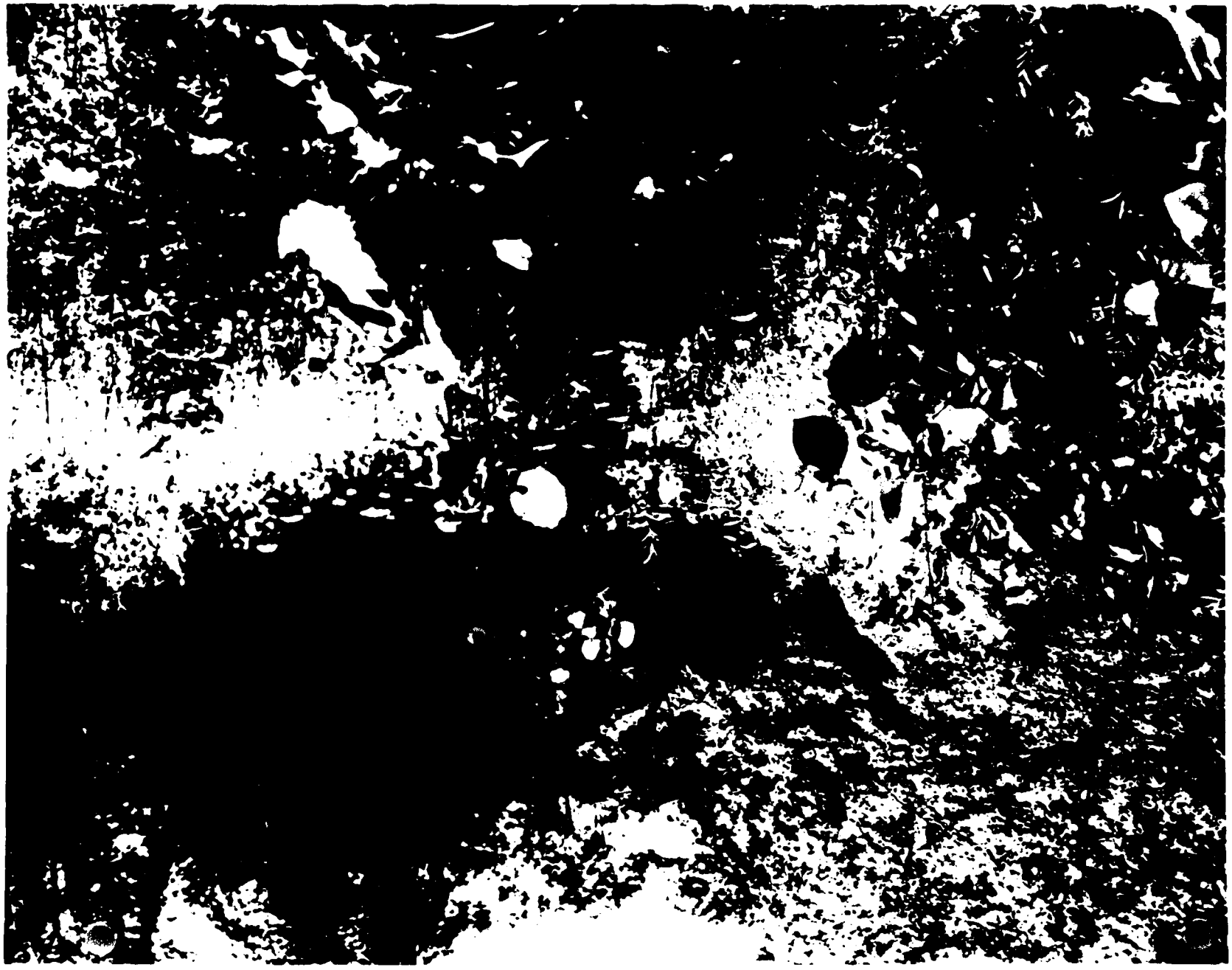
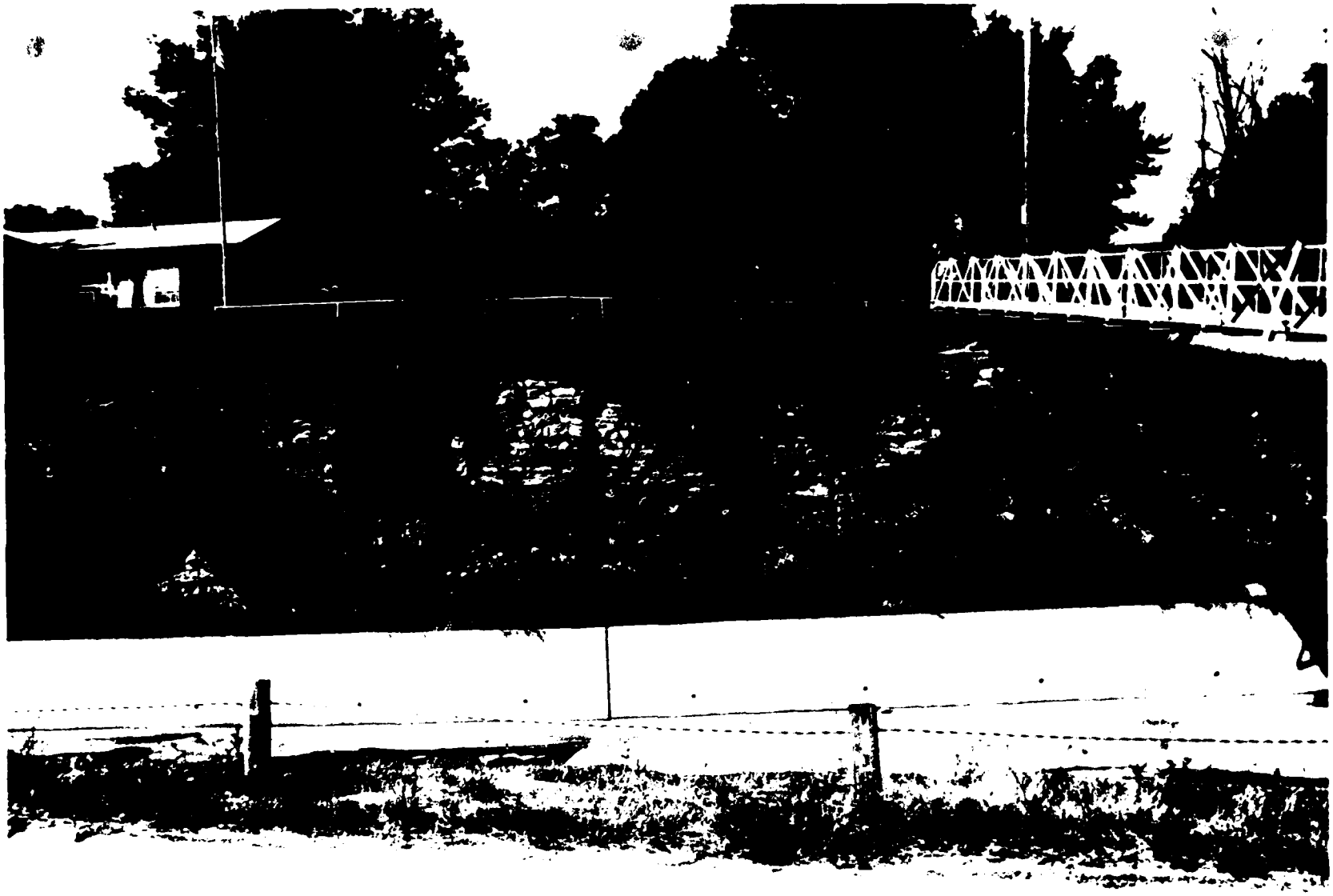
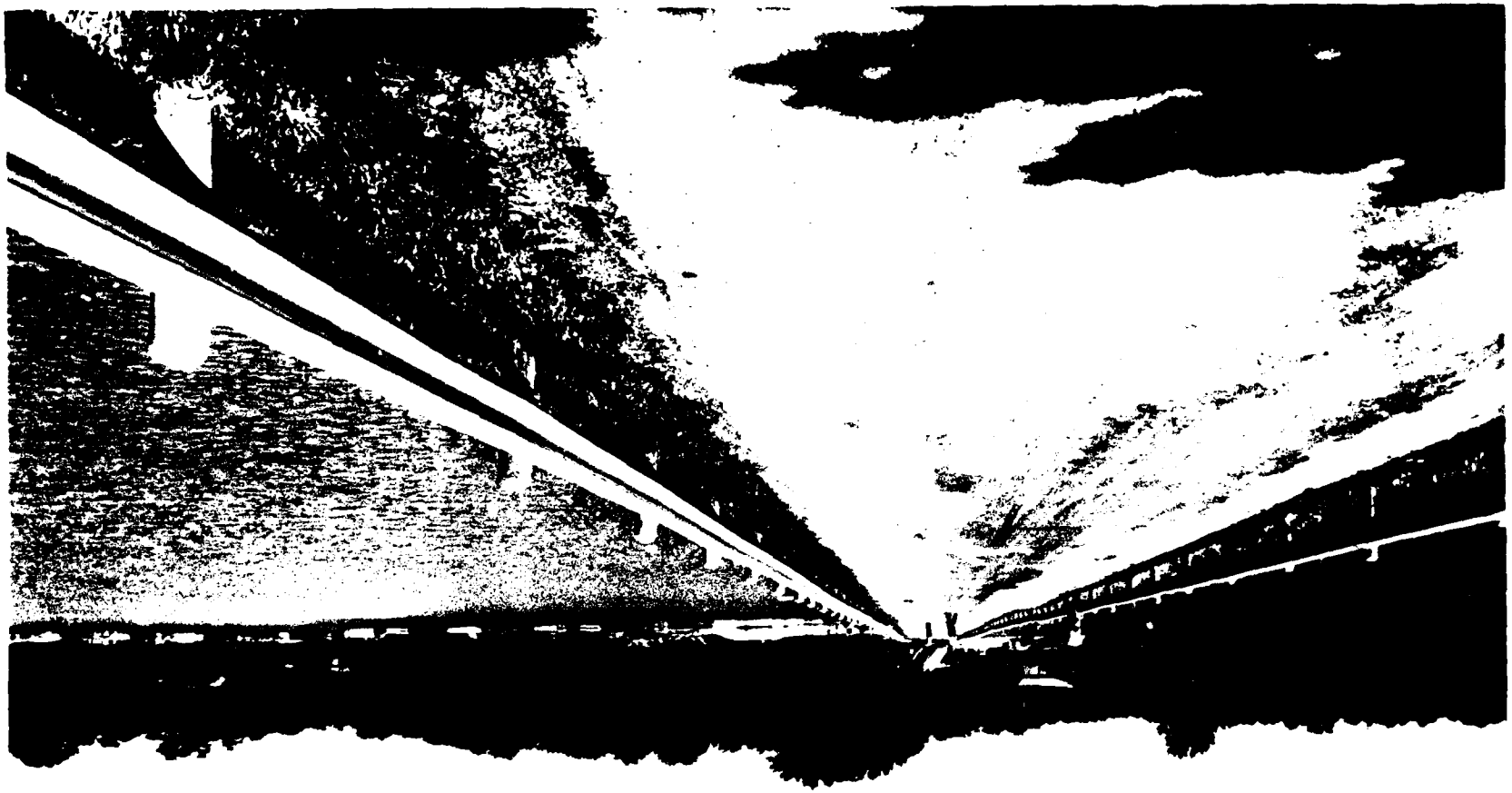
01

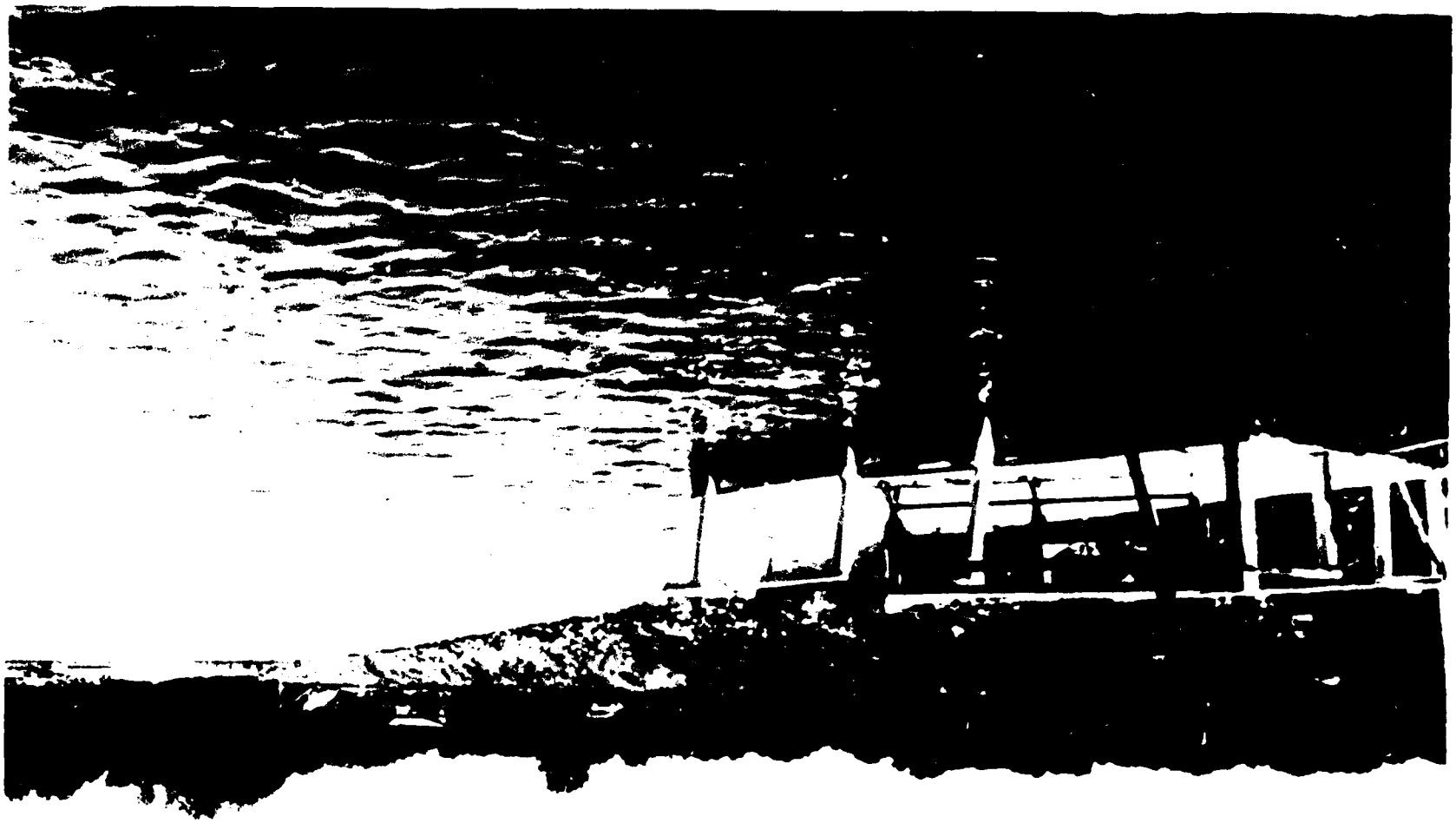


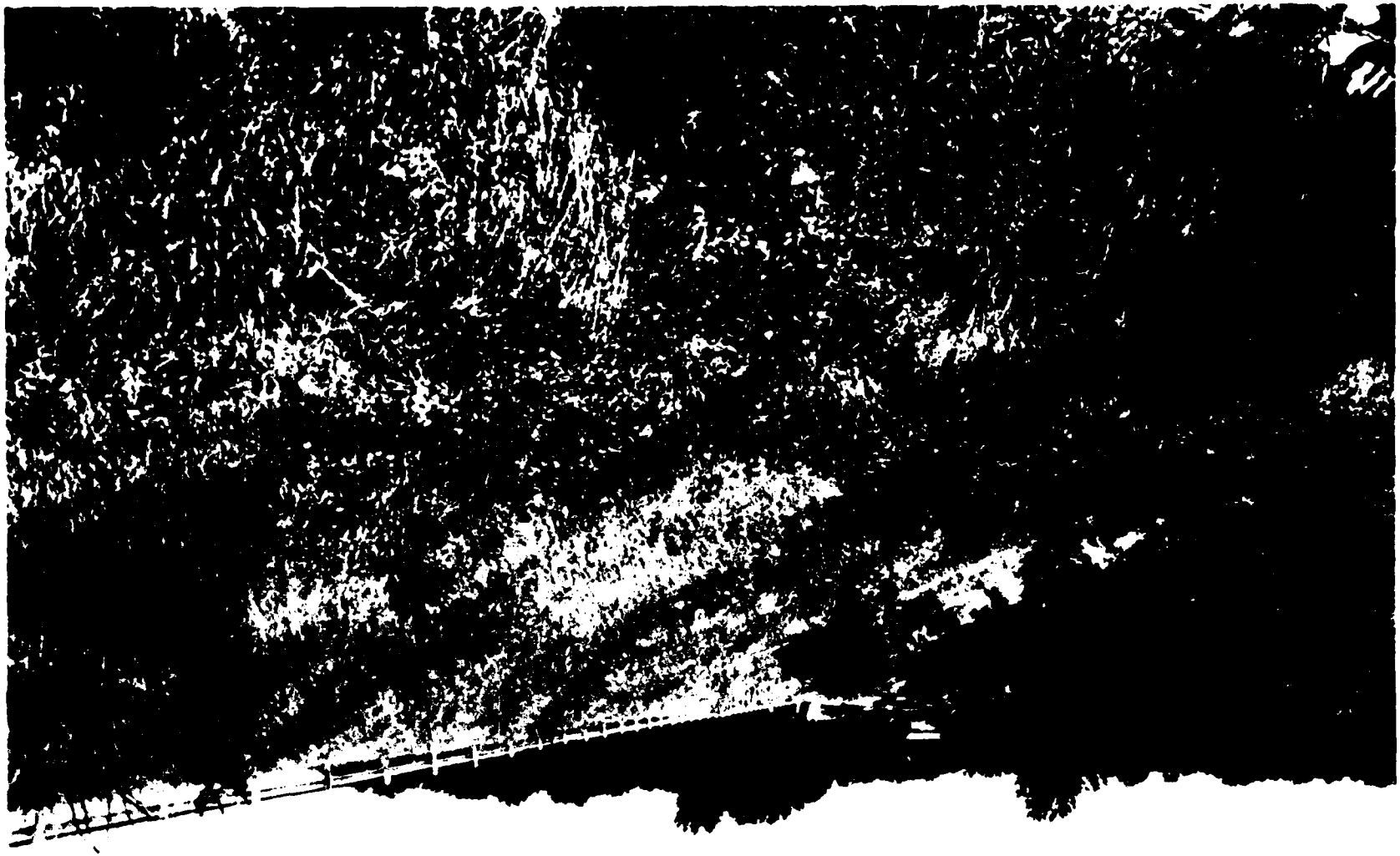


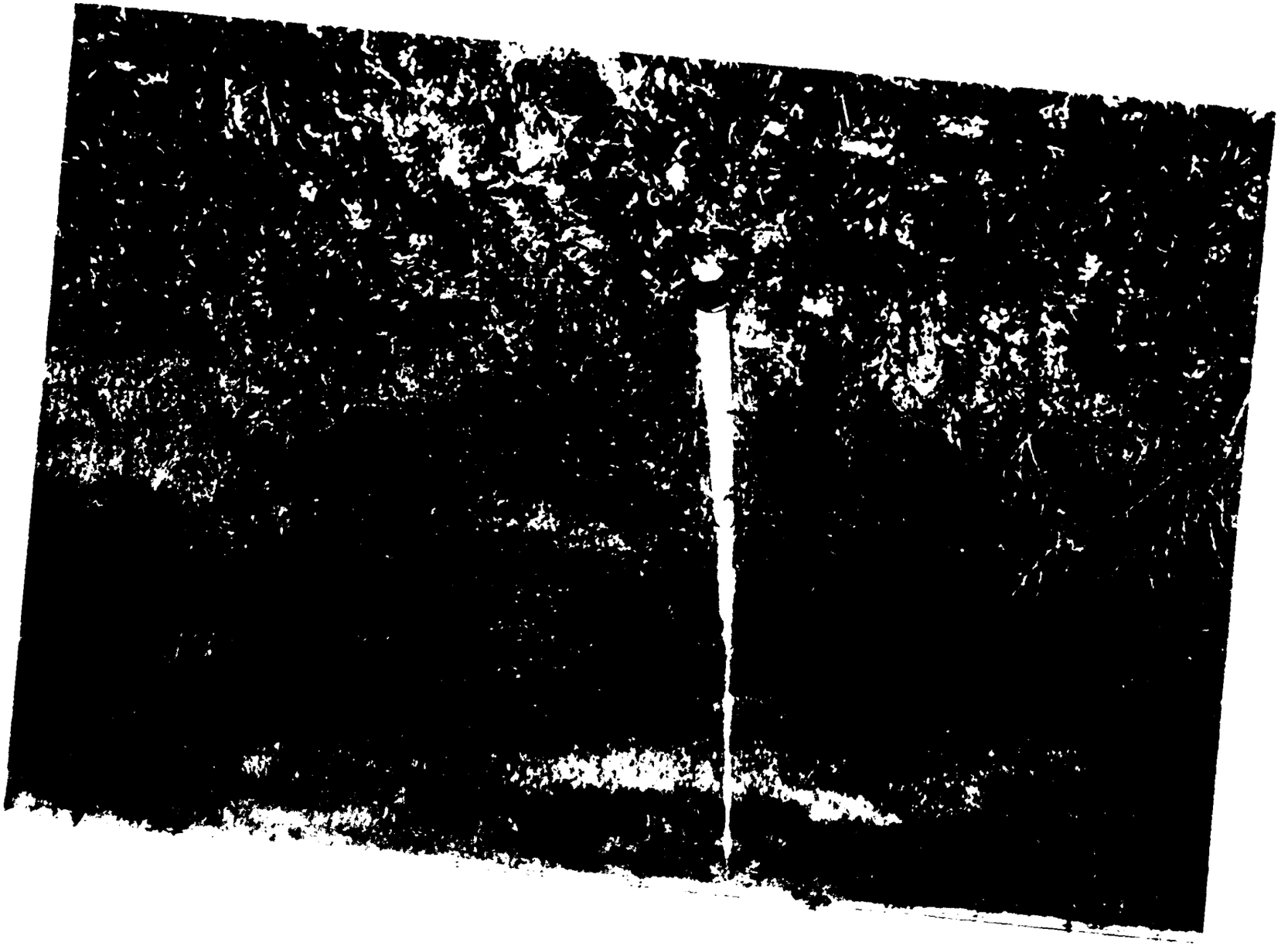
12



L1







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